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THE

ENGLISH CYCLOPÆDIA.

A New Dictionary of Universal Knowledge.

CONDUCTED BY CHARLES KNIGHT.

ARTS AND SCIENCES.—VOLUME II.

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THE

ENGLISH CYCLOPÆDIA.

ARTS AND SCIENCES.

BATHS AND WASHHOUSES, PUBLIC. Until within a very few years there were in England no public bathing establishments which in any measure answered to the *Thermæ* of the Romans [BATH], places where, for a very moderate sum, the poorer, as well as the more affluent classes, might enjoy the use or the luxury of a warm, a tepid, or a cold bath. There were numerous "Baths," but they were private ones of a comparatively expensive character. It is certainly remarkable that the metropolis of England should have been so long behind that of other countries in providing inexpensive and convenient public baths. But so it appears always, or almost always, to have been. Among the vestiges of Roman London the remains of baths, and especially of warm baths, have been frequently discovered in the course of excavations made both within the walls of the ancient city and outside of them. Even at the present day, in one of the curious narrow lanes which extend from the Strand downwards to the Thames, called Strand Lane, may be seen one of these old Roman baths, with the clear spring flowing into it, and still quite available for its original purpose. Remains of another Roman bath, which were found in digging for the foundations of the Coal Exchange, have also been preserved, and may still be seen. Like the other Roman baths found in London, these, however, belonged evidently to private houses; but it is probable that public baths were provided for the use of the citizens. In Rome, as we have seen [BATH], the public baths were numerous and on a magnificent scale. In other cities there were also public baths; nor is it likely that *Londinium* was unprovided with them, though they were perhaps of a comparatively humble class. Be that as it may, there are no traces or records of public baths in the city subsequent to the Roman dominion. The citizens, however, had their Thames, not then a polluted stream; and there were several smaller streams, now diverted or wholly lost, or else perverted into sewers. There would seem, moreover, from the statement of Fitz Stephen, who wrote in the reign of Henry II., to have been wells or springs which were resorted to for bathing. It is not clear however, that these were properly bathing-places, though, from the way in which Stow speaks of them, it is likely they were. Stow (1598) especially mentions a bathing-place well known in our own time: "Somewhat north from Holywell is one other well, carved square with stone, and is called Dame Annis the Clear; and not far from it, but somewhat west, is also one other clear water, called Perilous Pond, because divers youths, by swimming therein, have been drowned." There is little doubt that swimming was always practised by the London youths wherever they could find a place fit to swim in, but baths, except for medicinal purposes, do not seem anywhere in England to have been constructed. Where, from its natural heat or supposed sanctity, the water was believed to possess peculiar curative properties, baths were indeed erected at an early period. The baths of Bath were perhaps never wholly neglected from the time of the Romans, who were well acquainted with their qualities. In the Tudor period medicinal baths were in great repute. At Holywell, in Flintshire, is a very beautiful edifice, erected by the mother of Henry VII., the lower part of which served the purpose of a plunging bath, while the upper part was a chapel; and the baths of Buxton were much resorted to before the Reformation. Still no public baths appear to have been anywhere erected for the mere purpose of ablution. In 1648, an ordinance granting to a Doctor Chamberlain, "that he might have the benefit of improving all baths for fourteen years together, for the good of the people," was read in the House of Commons, and committed; but his "improvement," no doubt referred to medicinal baths. It was not till the reign of Charles II. that the want of public baths was, in a measure, supplied; three or four *bagnios*, as they were called, being then erected in London. These were, however, only for the wealthier classes, the charge being 4*s.* for each person; and, in fact, they were in a measure medicinal, being for "sweating, hot bathing, and cupping;" and, as they are described as after the Turkish model, they were, no doubt, pretty much like the shampooing baths of the present day. These places became the resort of disreputable persons, and fell into discredit, the very name being long generic for a house of ill-fame. In the course of the 18th century, a few baths were opened. Perilous Pond, its name being changed into Peerless Pool, was in 1743, walled in, enclosed, and converted into an excellent swimming-bath. Others of a like character were formed in subsequent years; and during the present century there had come to be a good sprinkling of swimming-baths about the metropolis, as well as several establishments for warm and cold bathing. The warm baths were, however, almost invariably too expensive for general use, and the favourite resort for swimming was, as it still is, the Serpentine, in which as many as 12,000 persons, it is said, in a report of the Humane Society (1850), have been counted bathing at once, early on a Sunday morning. The canals in the vicinity of London were and are also resorted to by a large number of bathers.

But if baths of any kind were rare, public washing-houses or laundries were quite unknown. In olden days, indeed, the English were not wholly, or perhaps generally, home-washers. The housewife or the laundress carried the linen down to the nearest convenient spot by the side of a stream, where "the shore was shelvy and shallow," like that which the whitsters [washers] of Windsor resorted to, by Datchet Mead, where Falstaff was so unceremoniously slighted from the buck-basket. It is on record that the corporation of Reading, upon the suppression of monasteries, petitioned for the grant of the Friary in that town, for a town-hall, because their old hall stood by the river Kennet, near the spot which was used by the townswomen for washing clothes; and the corporation say in their petition that the noise of the women's clappers caused great interruption to the transaction of public business. These clappers were, of course, wooden ones. Washing in cold water, they used wooden battledores to beat their clothes, just as the *blanchisseuses* of the Seine do still. In the present day, washing by the river-side is, we believe, nowhere to be seen in England, but it is common enough in Scotland, Wales, and Ireland; and, as is well known, the Parisian laundresses pretty generally resort to washing-boats on the Seine. In Pepys's day, London families would seem to have sent their linen to be washed by their servants at some washing establishment; for that most valuable of diarists tells us, that on August 12th, 1667, he dined all alone, "my wife and maids being gone over the water to the whitster's with their clothes, this being the first time of her trying this way of washing her linen." Again he notes (August 19th, 1668), "This week my people wash over the water, and so I little company at home;" by which we may suppose that Mrs. Pepys was satisfied with her trial of "this way of washing her linen," as she continued to practise it for above a year.

It was reserved for our own day to establish public baths and laundries for the community generally, and for the poorer portion of it in particular. The practical philanthropist early saw that the sanitary improvement of the condition of the poor in our larger towns was a work loudly calling for accomplishment. Medical men, clergymen, city missionaries, parochial officers, and all whom either professional duty or benevolence had led to enter the dwellings of the very poor,

however their opinions differed in other respects, were at least unanimous in declaring that those dwellings exhibited a degree of dirt and squalor with which health and morality were alike incompatible. Many remedies for the evil were suggested, and several carried into execution. One little knot of practical men resolved fortunately to give their special attention to the matter of personal cleanliness. It had been allowed by all who were really acquainted with the homes of the very poor, that in their crowded and wretched dwellings cleanliness was impossible. In such places not only were there scarcely the means for personal cleanliness, but to wash and dry clothes properly was quite impracticable. It was proposed, therefore, to see whether the establishment of places where, for a small charge, a warm bath could at any time be had, and where all the conveniences for washing and drying clothes should be provided free of charge, or at a trifling cost per hour, would not be gladly accepted by the classes most requiring such conveniences.

The movement was practically initiated by the holding of an influential meeting at the Mansion House, under the presidency of the Lord Mayor, in September, 1844, when resolutions were passed for the formation of an "Association for Promoting Cleanliness amongst the Poor;" and an active subscription was commenced. The first experiment was made in a wretched locality near the London Docks, where in an open court, called Glasshouse Yard, Rosemary Lane, an old but capacious building, which had for some time been occupied by "sleeping-berths for the houseless poor," was rented and converted into the first "Free Baths and Wash-houses," and opened in May, 1845. A portion of the building was adapted, as well as it could be at a small expense, to the purpose, and furnished with a due supply of tubs and boilers, and with a few baths in various out-of-the-way recesses; and soap and soda, as well as hot and cold water, were provided gratuitously. The number of persons who availed themselves of the establishment was, in the first year, 27,662 bathers, and 36,577 washers; in the second year there were 84,584 bathers and washers. This, though the first establishment of the kind in London, was not the first in England; a very small one having been previously started, and with much success, in Liverpool, though without the knowledge of the London Committee. The Glasshouse Yard establishment owed its success solely to its usefulness. There was nothing extrinsic to render it attractive. It was placed in one of the worst spots in the metropolis; the building itself was as little suited to the purpose as any building well could be; the accommodation was of the most ordinary kind. Yet it at once proved—if proof were needed—that the poorest in that wretched neighbourhood would gladly be clean when the means were attainable. In August, 1846, a second, and much superior establishment, was opened in George Street, Euston Square; a plot of ground having been liberally offered by the New River Company, near one of their reservoirs, with the additional advantage of a free supply of water for the first six months. In the first year there were here some 113,000 bathers and 20,000 washers. This establishment, in which the baths are more varied in price than elsewhere, still flourishes.

The establishment third in point of date was, however, the first in importance and in the value of the consequences which resulted from it. In this the committee first fairly developed their plans. Although the building in Glasshouse Yard was opened gratuitously, it had been desired that the institution should as soon as practicable be rendered self-supporting by means of a small charge to each person who used it. The committee hoped too, to see the system extended throughout the country; and they rightly thought that nothing would so effectually and speedily further that object as to be able to show a Model Establishment, which, while it contained all the conveniences and appliances which those who availed themselves of it could desire, should be in itself all that science, combined with practical skill, could effect in the economy, suitableness, and completeness of its arrangements. Accordingly, architects and others were invited to send in designs for baths and laundries, and all the information which could be obtained was collected. The Model Establishment was then erected on a site which had been purchased in Goulston Square, Whitechapel, a very poor and crowded neighbourhood, but of ready access. The arrangements being almost entirely novel caused a very large original outlay, and many changes have been subsequently made; but as a whole they had been so carefully considered, and were so judiciously designed by Mr. Prichard Baly, the committee's engineer, that no material alteration has since been found necessary; indeed, in a recent Report of the Committee, we are told that "the general arrangements and mode of construction have been almost universally followed in London and the country."

In general character, then, these establishments are pretty much alike. A brief sketch of the interior of any one will serve to give a general conception of all, it being understood that there are differences of detail in each.

The baths for males and females are on opposite sides of the building, and separated in Goulston Square by the washing-room, in some others by the plunging-baths. In both sides are first- and second-class baths. The apartment in which these are placed is spacious and lofty, covered by an open roof, and lighted in the day by ample skylights; by gaslights at night. Each bath-room is a distinct compartment, somewhat more than six feet square, shut in by walls of painted slate, which are carried up to the height of some ten feet; but the top is

open, so as, while ensuring privacy, to admit of thorough ventilation. The bath, in some establishments sunk in the ground, in others placed as usual above it, is either of iron enamelled, or of zinc. The first- and second-class rooms are usually alike in every respect, except that the fittings in the first-class rooms are of a superior kind, and more complete than in the second. On each door is a porcelain knob, having a number painted upon it; a similar number is painted inside. An index outside enables an attendant to let in either hot or cold water, as the bather may direct. The charge for a first-class warm bath is usually sixpence, for which two towels, flesh and hair brushes, and a comb, are allowed. For a second-class bath the charge is twopence, but only one towel is allowed, and the bather must provide his own comb and brushes. The baths are in all respects alike, the same quantity of water (in most places forty-five gallons, but at St. Martin's much more) is allowed, and the bath is invariably cleaned after each person. The most perfect cleanliness is indeed observed in every respect. For a cold bath the charges are respectively threepence for a first- and one penny for a second-class bath: the regulations are the same as with the warm baths. The baths on the female side are similar to the others, but there is a little more taste in the first-class fittings. At Goulston Square there are only warm and cold baths. At St. Martin's a shower-bath is added. At George Street there are also vapour-baths. At all the more recently constructed establishments there are plunge or swimming baths filled with tepid water. For these swimming-baths the charge is usually fourpence for the first-, and twopence each person for the second-class. At the larger of the recent establishments there are two swimming-baths—a first and a second class; the smaller places have only one large bath, using it three days a week as a first-, and the other three days as a second-class bath.

The baths have everywhere proved exceedingly popular. The second-class baths are, in the summer particularly, always well attended, and of an evening there are generally many waiting for their turns, which are always strictly in the order of arrival.

The number of baths varies, of course, according to the requirements of the locality, and the size of the building. The number of first-class baths, for example, at St. Martin's-in-the-Fields, is twenty-four men's, five women's; of second-class, thirty-three men's, and eight women's. At Goulston Square, there are ninety-four first- and second-class baths. At St. James's, Marshall Street, there are only about fifty of both classes; but there is a swimming-bath. The number of bathers at Goulston Square in the year is above 150,000; at St. Martin's-in-the-Fields the number is above 200,000.

The *Wash-houses* are more remarkable than the bathing-rooms, because entirely unlike what is seen anywhere else. Along the centre, on one side, and at the ends of a large and lofty room, are ranges of little doorless and roofless compartments, the walls being of unpainted slate, and some six or eight feet high: these are the washing-places. At convenient points are the wringing-machines. Along one side of the room (at Goulston Square) is what looks like a range of wide but shallow deal drawers, turned up endways, the handles being one above the other—that is the drying apparatus. A long flannel-covered board is furnished for ironing on. In some of the latest wash-houses a mangle is provided.

Each washing compartment is 6 feet long by 3½ feet wide. At the end are two wooden troughs, which serve as a washing-tub and a boiler; these are furnished with taps for hot and cold water, for steam, and for letting off the waste water, so that the tubs are filled and emptied without any more trouble on the part of the washer than turning the tap, and without moving from her standing-place. The water in the boiler is made to boil by the admission of steam into it, which, as we said, the washer can do whenever she pleases. The ventilation is so arranged that the steam from each compartment is at once drawn upwards, and carried off to the great ventilating shaft.

The wringing-machine is in effect a sort of wide but shallow colander; the sides, instead of the bottom, being perforated, or rather formed of galvanised wire, so arranged that the meshes are about a quarter of an inch apart. When the wet clothes are put in this, it is set in rapid motion by a handle, which works a few connecting wheels; the clothes at once, by centrifugal force, arrange themselves around the sides, and the water is rapidly driven out between the wires, and carried off by water-pipes: an opening at the foot of the machine shows when the water ceases to flow, and when, consequently, the "wringing" is completed, and then the pressure of a lever at once stops the machine. The machine has rather a heavy look, but the turning of it is really very light work, and by it three minutes suffice to rid even a thick blanket of its moisture. The drying-chamber is a long chamber, heated by hot air to a temperature above 212°, and divided into numerous smaller chambers, so as to separate the clothes of the washers. Each division of the chamber contains a clothes-horse or maiden, one being allowed to each washer. In ten minutes or a quarter of an hour the clothes, unless very heavy or numerous, are quite dry. The committee have published a table in one of their reports, to show the rapidity with which the drying is accomplished. Some of the results are curious. We may take a single instance as an illustration of the processes we have been following. Three large dirty blankets weighed before being washed 9 lbs. 1 oz.; after washing they weighed 24 lbs. 14 ozs.; after leaving the wringing-machine, 12 lbs. 3 ozs.; after being dried, 8 lbs. 12 ozs. These blankets took 25 minutes to

dry, at a temperature of 210°. In all other cases the results were similar, establishing the fact that "the articles, when taken from the drying-chamber, contained decidedly less moisture than they did when they were received for the wash." To show the "satisfactory working of the drying-chamber at the model establishment, and also its great advantage in the economy of time, trouble, and expense to those of the labouring classes who resort to it," the committee give a return of the articles dried there in one week ending January 24, 1852. It is too full for us to copy; but we may state, that the number of articles of all kinds, from counterpanes, jackets, and trousers, down to shirts and stockings, was 36,844, belonging to 1373 washers, who occupied 2999½ hours in washing, drying, and ironing them; and that the drying consumed only 282 bushels of coke, which cost under 4*l*. In some of the buildings last erected, efforts have been made to economise still more the cost of this and other operations.

In most of the establishments there is only one class of washers; but in some there are both first and second classes, the difference being that the first class have a somewhat larger compartment allotted to each washer, and a third or rinsing-tub. The charge for the use of all the apparatus we have described is now generally 1½*d*. an hour, though in a few places it is only 1*d*. an hour. Where there are both classes, the charge is 2½*d*. an hour first-class, and 1½*d*. second. Soap, soda, &c., have to be found by the washers. The number of washing compartments varies, of course, according to the size of the establishment: at Goulston Square there are 84 of them; at St. Martin's, 56. The average time occupied by each washer at the model establishment is two hours and a half, and this is the general average time in London; in some country towns it differs considerably. In London it seems pretty well established, that the active wife of a labouring man can at one of these places wash and dry the clothes of her family in two or three hours. The ironing, at least in part, is generally done at home.

Let us look a little at what has been accomplished. In August 1846 the royal assent was given to an Act to encourage the establishment of public baths and washhouses, which, as amended in the session of 1847, empowered parish vestries and borough councils to establish such institutions, and, with the sanction of the Treasury, to borrow money for the purpose on the security of the borough fund or poor's rates. A schedule directs, among other very excellent rules, that baths must be provided in them at 1*d*. for cold and 2*d*. for warm baths; and that the washhouses shall be furnished with necessary conveniences at a charge not exceeding 3*d*. for two hours. Baths and wash-houses of a higher class are to be charged as the council and commissioners respectively think fit. The baths and washhouses "for the labouring classes" in any such establishment, must be not less than twice the number of those of any higher class. This Act at once gave the system a firm standing; and both boroughs and parishes have availed themselves of its powers to a considerable extent. Of course, it is not always easy to persuade vestrymen to permit an addition to be made to their parochial rates for a purpose that does not promise advantage to themselves; but as it has become year by year more evident that these institutions may be made self-supporting, and in due time repay the amount expended on their foundation, so there has been a growing readiness to found them. In London and the suburbs, besides the model establishment in Goulston Square, and that in George Street, Hampstead Road, there are several large parochial establishments, some of which are fitted up in an extremely complete manner, while all are well attended by both washers and bathers. Manchester and Liverpool have each several baths and washhouses, and almost every other large town throughout the country is either provided, or taking measures to be provided, with similar establishments; and the example has been followed by several of the smaller towns. Nor have the good effects of the movement been confined to this country. The Committee for Promoting the Establishment of Baths and Washhouses for the Labouring Classes were able, at the end of 1852, to state in the report before quoted, that the governments of France, Norway, and Belgium, the municipality of Venice, and the authorities at Hamburg, Turin, Munich, Amsterdam, Lisbon, and New York, had applied for and been furnished with information on the subject; and in some of these countries the example of England has since been followed in providing similar establishments for the labouring classes.

It is evident that the institution has become firmly established. In London alone the bathers number upwards of two millions a year, while the washers exceed half a million. The constantly increasing number of bathers and washers shows that the system is commending itself to a large section of the population. The experience of twelve years has proved that, with proper attention and economy, the establishments may be rendered self-supporting; and the observations of all who have watched them in particular localities vouch for their beneficial influences. The point in which they appear to have failed is, in reaching the very poorest. That portion of the community for whom the institution was primarily intended, seems to have been scarcely touched by it. Everywhere those who avail themselves of the benefits offered are of a class above the poorest. The most profitable section of the establishment is found to be the "first class." Whether availing themselves of the hint, the managers of these establishments might not, by furnishing a yet higher class bath (though still at a moderate price), provide the means by which they might support one of a cheaper kind than they have at present been able to afford, and so extend the benefits of the system both upwards and downwards, is a question perhaps deserving of more attention than it has hitherto received.

BÂTMAN (pronounced Bawman), a soldier told off for a particular duty: as, when a battalion takes the field, and the tents are conveyed on horses, one bâtman is allowed, by the "Queen's Regulations for the Army," to each of the field-officers, one to the staff, and two to each of the companies, for the care of the horses carrying the camp equipage; and those men are, for the time they are thus employed, exempted from all other regimental duties. The horses above specified are termed bât-horses, for the purchase of which the officer commanding the company is allowed a sum of money, and for which forage is provided by the commissariat. For regiments on duty in the kingdom, the bâtman and bât-horse of course become unnecessary.

BATRACHOMYOMA'CHIA (Βατραχομυομαχία), *the battle of the frogs and mice*, is the title of a Greek poem, consisting of 294 hexameter verses. This poem, though generally ascribed to Homer, and printed with the editions of the Iliad and Odyssey, undoubtedly belongs to a late age, and is attributed by Plutarch and Suidas to Pigres, of Halicarnassus, in Asia Minor. Pigres is called by Suidas the brother of that Artemisia who was the wife of Mausolus. This poem, however, is probably the composition of some still later writer of the Alexandrine school. Some critics consider it a satirical poem: as it is not very long, the reader may form his own opinion without much trouble. Parnell has translated it into English verse.

BATTA, an allowance made to military officers in the service of the East India Company, in addition to their pay. As the officers of Queen's regiments serving in India receive their pay according to the scale fixed by her Majesty's regulations, and which pay is below the emoluments derived by officers of similar rank in the regiments of the East India Company, the allowance of batta is made also to them by the Company, and is so adjusted as to preserve an equality of income between the two services.

The scale of allowance under the name of batta varies not only with the circumstance of the regiments being in the field or in cantonments, but also according to the part of the country in which they are stationed.

Batta was originally given with the intention of enabling officers to provide for field-equipment, and for those extra expenses which they must incur when marching; but it early lost this character when it was continued to officers in cantonments. In November, 1828, the distinction was made between the amount allowed when in actual service, and when in cantonments; before that time no difference was made. The effect of the alteration is this: that at stations, whether in garrison or cantonment, within 200 miles of the seat of government of each presidency, where an officer formerly got full batta, he now gets half that batta, with an allowance for house-rent, which is inferior to what the other half of the batta would be. The half-batta of a lieutenant-colonel is 304 rupees (about 30*l*.) per month; his allowance for house-rent is 100 rupees. A major's half-batta is 228, and for house-rent 80 rupees per month; captain's half-batta, 91, and house-rent, 50 rupees; lieutenant's, 61, and 30 rupees; ensign's, 46, and 25 rupees. Colonels of regiments, not being general officers on the staff, nor holding offices specially provided for, are allowed the full batta of 750 rupees per month at any station, but they have not any allowance for house-rent. It was estimated that, by carrying into effect the regulation of November 1828, the government of the East India Company would save 12,000*l*. per annum. In the field, and in garrison or cantonment, beyond 200 miles of direct distance from the seat of government of each presidency, full batta is allowed: or rather the other half batta, which is now called extra batta.

BATTALION. This name is applied to a certain division of the infantry in an army, corresponding, nearly, to the *chiliarchia* in a Greek phalanx, and to the *cohort* in a Roman legion. The number of men composing a battalion is variable, but in the British service, according to the present establishment, it consists of ten service and two depôt companies, which at their service strength of 100 rank and file each, would give 1200 men; or 1000 with the service companies and 200 at the depôt. This is the strength in rank and file of a battalion on the Indian establishment, making, with 91 non-commissioned officers, trumpeters, and drummers, and 48 officers, a total of 1,339 of all ranks. The battalions on the home establishment consist likewise of 10 service and 2 depôt companies, or 950 rank and file—of which 150 form the depôt companies—25 drummers, 56 sergeants, and 46 or 45 officers, according as it is the first or second battalion, making a total of 1,077 of all ranks. A battalion of the Guards is somewhat smaller, there being only 10 companies, or 800 rank and file, which with 61 non-commissioned officers and drummers, and 38 officers, gives a total of 899 of all ranks. The number of battalions in a regiment varies; at present, of the three regiments of Guards, the Grenadier Guards is composed of three battalions, while the Coldstream and Scots Fusilier Guards contain only two each. Of the 100 regiments of infantry, the 24 first contain two battalions each; the 60th or Royal Rifle Corps, four battalions, and the rest one each. The Rifle Brigade consists of four battalions. There are, therefore, now, 138 battalions of British infantry, exclusive of the Royal Marines, three West India regiments and Colonial corps. And there are fourteen battalions of artillery, besides the Horse Brigade.

It seems, therefore, that, originally, the name of regiment was applied to the body of men organised for a particular district, or a particular branch of service; and that, when the numerical strength of the regiment exceeded what was considered convenient, it was divided into two or more battalions. Battalions may, therefore, be defined as the units of the modern tactical system and composition of infantry, which is arbitrarily divided into regiments. The number of battalions in a regiment varies much in the different armies of Europe; the strength of a battalion, however, is generally about 800 or 1000 men.

The phalanx of the Greeks, and the legion of the Romans, with their respective constitutions and divisions, will be described under the words PHALANX and LEGION.

The destructive effects of fire-arms among dense bodies of men necessarily caused the close order of battle used in ancient warfare to be abandoned: though, down to the middle of the 18th century, an opinion that the troops could not otherwise resist effectually a charge of the enemy, and the desire to form them with facility into a column for attack, induced commanders of armies to draw up the battalions in a line from four to six files deep. But the numerous casualties which still occurred, led subsequently to the practice of forming the line in three ranks; and in the present regulations for the disposition of the British army, it is prescribed that the battalions are to be drawn up in two ranks only. The argument in favour of this method, which, it may be observed, was recommended, in 1783, by Turpin, the commentator of Vegetius, is, that in action two ranks of men only can fire at once, and as the third rank can only be employed in loading, and handing the muskets to the men in their front, this service scarcely compensates for the loss occasioned by the exposure of so many men to the enemy's fire. This is fully borne out by Marshal Marmont, Duke of Ragusa, in the following passages, which are extracted from a translation of his work which appeared in the 'United Service Journal,' for February, 1845: "Nothing can be said in favour of a third rank, for without entering into a detail of volleys, persons of experience know that if one can, at a review, fire a volley in three ranks, it is impossible in war." A foreign writer, however, contends that with soldiers as well disciplined as those of Russia, three ranks would be more advantageous than two: since the men in the middle rank are enabled to fire a second time with the muskets obtained from those in the third rank, immediately after they and the front-rank men have made their first fire, so that a much less interval takes place between the vollies than that which occurs when the line consists of only two ranks. Marshal Marmont says it is ascertained to be impracticable to hand over the firelock to the third rank as the French order prescribes. "This method, being merely theoretical, is by no means applicable to the face of an enemy. In fact, the third rank, of its own accord, in a few moments, forms into the other two; the most advantageous formation is, therefore, instinctively adopted; but as the change is made contrary to order, there results from it a kind of disorganisation."

During the wars which arose out of the revolution in France, the armies of that nation became habituated to a formation in close columns instead of a line of small depth. This practice, which seemed to be a return to the tactics of the ancients, possesses some advantages when an attack is to be directed against an enemy's line which is too far extended to allow the divisions to succour each other in time; and the great merit of Napoleon consisted in manœuvring so as to lead his opponent to fall into this error, and then overwhelming him by numerous consecutive and powerful attacks directed against the weaker part of his line. The system, however, seems to have been persevered in too tenaciously by the French generals; for against steady troops, their columns not only suffered serious losses in making the assaults, but were incapable of keeping up a fire equal to that which might have been produced by a more extended order. Such was the error committed by Marshal Soult at the battle of Albuera. According to Napier ('History of the Peninsular War), "that general persisted beyond reason in fighting with dense columns, and thus lost the fairest field ever offered to the arms of France. Had the fifth corps of the French opened in time," the historian observes, "nothing could have saved the British army from a total defeat."

A battalion of 800 men, that is disregarding the depôt, is divided into ten companies; and, for convenience in performing the movements which may be required, each company is subdivided into two equal parts, and each of these into sections. The battalion is commanded by its own colonel; and several battalions or regiments are, on service, united under one general officer; these constitute a brigade, and may be considered as a small legion. According to the present regulations each man occupies in line 21 inches, and, as no intervals exist between the companies, the extent of a battalion formed two deep, is about 240 yards. Six paces are left between every two battalions, and the same interval only separates one brigade from another.

The company of grenadiers occupies the extreme right, and the light company the extreme left of the battalion: these are called the flank companies, and the others take their places from right to left, according to the numbers by which they are designated. The captain, or officer commanding each company, is stationed in the front rank on the right of his company; and immediately behind him, in the rear rank, is his covering sergeant. The lieutenants, ensigns, and the sergeants of the companies form a third, or what is called a supernumerary, rank in rear of the others, at the distance of three paces. The two regimental colours are placed in the front rank between the two centre companies, and two non-commissioned officers are in the rear rank behind them; a sergeant is stationed in the front, between the colours, another stands opposite to him in the rear rank, and a third in a line with both, in the supernumerary rank. These last-mentioned sergeants serve to direct the march of the battalion when it moves parallel to its front; for which purpose, on that occasion, they form themselves in a line in that direction, and march before the battalion at the distance of six paces.

The commander of the battalion places himself in front when he has to superintend the ordinary exercises, otherwise his station is in the rear. The lieutenant-colonel is behind the colours in rear of the supernumerary rank; the majors are in rear of the second battalion companies on the right and left flanks respectively, and the adjutant in a line with them, opposite to the centre. The situations of the *Staff* of the battalion, the musicians, &c., together with the particulars above briefly stated, are fully described in the treatises on the field exercises and evolutions of the British army.

Originally the grenadiers performed the duty of throwing hand-grenades, or small iron shells charged with powder, among the enemy; and the firelocks of the fusiliers and light infantry were different from those of the other troops; but, at the present day, all the infantry of the line carry the same kind of musket, namely, the Enfield rifle.

The principal evolutions of a battalion consist in reversing the front of the line, taking a position at right-angles to its actual front; forming a column by bringing the different companies or their subdivisions parallel to, and directly in rear of each other, either at open or close intervals; forming a column *en échelon*, or with the divisions parallel to, but in positions receding from, each other towards the right or left, in the manner of steps; or, lastly, forming a hollow square. By changing the front, a retrograde movement in line may be made; by forming the line perpendicularly on either flank, an attempt of the enemy to turn it may be opposed. Columns are formed for the purpose of marching along roads or through defiles, or advancing in a body towards an enemy's position; a movement en échelon allows troops to gain ground obliquely towards the front or rear; and a hollow square is formed in order to resist an enemy in every direction, when the battalion is in danger of being surrounded.

(Turpin de Crissé, *Commentaires sur les Institutions Militaires de Végèce;* Daniel, *Histoire de la Milice Françoise;* Okounef, *Examen Raisonné des Propriétés des Trois Armes;* Bismark on the *Tactics of Cavalry*, translated by Major Beamish; *Regulations for the Formations, Field Exercises, and Movements of her Majesty's Forces.* For many particulars relative to the present state of the British army, the *Monthly Lists* may be consulted. See also *R. E. Aide-Mémoire*, art., Evolutions of Infantry.)

BATTARDEAU. [COFFER-DAM.]

BATTENS. One description of sawn fir timber planks of small dimensions, imported from the north of Europe, or from America, is known in commerce under the name of *battens*, by way of contradistinction to the other descriptions known respectively as *deals* and *planks*. Battens are of various lengths, from 10 to 14 or occasionally 16 feet, and generally 7 or 6½ inches wide by 3, 2½, or 2¼ inches thick; they are sold, however, by what is called the Petersburg standard, which is equivalent to 120 battens 12 feet long, 7 inches wide, by 2½ inches thick. The present duty upon their importation is at the rate of 10*s.* per load of 50 cubic feet, from foreign countries; or 2*s.* per load when of or from British possessions; in the latter case 5 per cent. additional duty is charged. The best battens come from Norway or St. Petersburg.

Battens are principally used for flooring purposes, or for covering roofs to receive slating, on account of their being less exposed to shrinking than other plank stuff, owing to their smaller scantling. It is customary to cut the 2½-inch battens, as imported, into two boards for floors, and into three boards for slating; sometimes in inferior floors battens cut into three boards are also used.

In joiner's work the term *batten*, or *battening*, is used to express the species of framing immediately attached to a wall, which subsequently receives any panneled wainscoting, or a canvas lining, introduced for the purpose of isolating the paper from the wall itself, or even of isolating the plastering of a room from the wall, if there should be any danger of the latter affecting the decorated surfaces by its humidity, or by its tendency to "saltpetre." In such cases the battens are usually made about 2¼ inches wide by 1¼ inches thick, and are placed at clear distances asunder of from 7 to 12 inches, according to the nature of the surface they are designed to receive; when the battens are intended to receive canvas they are made wider, but are placed at rather greater intervals. Sometimes the laths nailed at intervals upon the common rafters of a roof to receive the nails of the slating, or the hook of tiles, are called incorrectly *battens*.

BATTERING RAM. [ARTILLERY.]

BATTERY (IN LAW). [ASSAULT.]

BATTERY, (ELECTRICAL and GALVANIC, or VOLTAIC). [ELECTRICITY].

BATTERY. This name is given to any number of pieces of ordnance

placed behind a parapet, or elevation of earth, either to defend a position, destroy the works, or dismount the artillery of an enemy. It likewise means the equipment of a certain number of pieces of artillery. [FIELD ARTILLERY.]

It may be said that the ancients made use of a species of ordnance in the operations of attack and defence; and the battering-rams, the balistæ, and the catapultæ, which, when placed on the natural ground, or in buildings of timber, or elevated on mounds of earth, served the besiegers to demolish the walls of fortresses, or to drive the defenders from them, may be considered as corresponding to the guns, mortars, &c., which constitute the armament of a modern battery.

Vitruvius states ('De Architecturâ,' lib. x.) that Cetras of Chalcedon was the first who covered the *ram* with a shed, in order to secure the men who worked it from the arrows, darts, and stones thrown by the enemy; and he adds, that the construction of the shed was subsequently improved by the engineers of Philip and Alexander. The *testudines* and *helépoles* were buildings of this nature, for the protection of the men and military engines, and in this respect they correspond to the parapets and *épaulements*, which cover the ordnance at present employed in the attack of a fortress. (See the description of the helépolis (ἑλέπολις) of Demetrius. Plutarch, 'Life of Demetrius,' cap. 21.)

While the same species of artillery continued to be used in warfare, it is evident that no material change could take place in the nature of the edifices constructed to cover it; but from the epoch of the invention of gunpowder, the wooden sheds or towers were superseded by masses of earth, whose thickness was necessarily made greater than the depth to which a cannon-shot can penetrate into them. In modern times the designation of a battery varies with the purposes to be accomplished, the nature of the ordnance employed, and the manner in which the firing may be made.

A *breaching battery* is one which may be placed at between 50 and 1000 yards from any wall or rampart, in order to demolish it; and the effect is produced at all times by firing perpendicularly to the front to be breached, and, if near enough, *point blank* at it; such a battery generally, therefore, has its front parallel to the face of the wall to be breached.

An *enfilading battery* is one whose parapet is perpendicular to the produced line of the enemy's rampart; so that the shot from the guns may graze the interior side of that rampart or its parapet, in the direction of its length. When shot discharged from pieces of ordnance make successive rebounds along the ground, the firing is said to be *à ricochet*, and the battery a ricochetting battery; and this mode of firing is employed when it is intended to dismount artillery by enfilading a rampart. The effect is produced by giving to the axis of the gun an elevation of between six and nine degrees above a line passing from its *chamber* through the crest of the enemy's parapet in front; and, according to the latest experiments, the distance at which a battery should be placed from the nearest extremity of the rampart to be enfiladed by ricochet firing is between 400 and 600 yards: at a greater distance than the latter much of the ammunition would be expended without effect.

A *gun battery* is one in which guns only are employed, for either of the purposes above mentioned, or to defend any ground, by a fire of round or solid shot.

A *howitzer battery* is one in which howitzers are employed. This species of ordnance throws shells, or hollow shot, generally at a small elevation of the axis to the horizon; and it serves to produce, by the bursting of the shells, a breach in a rampart of earth; or, when fired *à ricochet*, to destroy the palisades or other obstacles which might impede the troops in assaulting an enemy's work. Howitzers are also used in conjunction with guns, to form breaches in ramparts of brick or stone.

A *mortar battery* is one in which shells are thrown from mortars at a great elevation of the axis of the piece; so that, by the momentum acquired in falling, they may crush the roofs, and by their explosion complete the destruction of magazines or other buildings. This is called a vertical fire. By employing large charges of powder, a very extensive range has been produced by mortars; for, at the siege of Cadiz, the French are said to have sent shells to the distance of more than three miles from the battery.

When the battery is mounted on a natural or artificial eminence, in order to allow the guns to fire from above downward, or to make what is called a plunging fire against or into the works of the enemy, it constitutes a *cavalier battery;* and when the guns are elevated on a platform, or on tall carriages, so as to be enabled to fire over the superior slope of the parapet or épaulement, the battery is said to be *en barbette*. This kind of battery is usually executed at the most advanced points of a fortress, for the purpose of allowing considerable lateral splay in the direction of the artillery to the right or left; by which means the reconnoitring parties of the besiegers may be annoyed while at a distance and in motion.

In the formation of any of the field batteries above mentioned, while they are beyond the range of the enemy's musketry, they may be executed without cover for the working parties, like any simple breast-work, after the outline has been traced on the ground by the engineers; but when the men employed in the work would be much exposed to annoyance from the enemy's fire, it becomes necessary that they should be protected by a mask of *gabions*. [GABION.]

These being planted on their bases along the exterior side of the intended trench in front of the battery, permit a cover, which a musket-ball cannot pierce, being soon obtained. Within this line of gabions the excavation is commenced, and part of the earth obtained from the trench is thrown into and beyond the gabions, till the covering mass is thick enough, if necessary, to be proof against a cannon-ball: the men thus work in comparative security to raise the parapet with earth, which they do generally to the height of about seven feet from the ground, and to the thickness of eighteen or twenty feet, not including the breadths of the slopes given to the exterior and interior sides. The exterior slope is generally left with that inclination which earth, when thrown up, naturally assumes, that is at about 45° to the horizon; but the interior slope being necessarily more steep, in order to allow the guns to be brought close up to it, is retained by a *revêtement* or covering, either of *fascines* [FASCINES], gabions, or sand-bags, bags full of earth. Batteries are termed *elevated*, *half-sunken*, or *sunken*, according to their method of construction. The parapet of the elevated battery is constructed of earth obtained from the ditch; of a half-sunken battery, part from the ditch and part from the interior; and of a sunken battery, wholly from the interior.

The *embrasures*, or openings in the parapet, through which the guns are to fire, are, at the *neck* or interior extremity, about two feet wide, and at the exterior about half the thickness of the parapet: each of their sides or cheeks has a small declination from a vertical plane, so that the breadth of the opening at top is rather greater than at the bottom, or on what is called the *sole* of the embrasure, in order that the flame from the muzzle of the gun may be less liable to damage those sides: for the same reason the latter are lined with fascines, or which is preferred, with gabions, at the neck of the embrasure. The interval between two embrasures is called a *merlon;* and the part between the *sole* and the ground within the battery is called the *genouillère*.

The guns rest on platforms, generally of timber, either of a rectangular or dovetailed figure. [PLATFORM.]

Besides the parapet which forms the front of the battery, a wing is constructed of the same materials on each side, called an épaulment, in order to protect the interior from any enfilading fire of the enemy. MAGAZINES are always formed either within or near the rear of the battery, to contain the ammunition for its service, in the proportion of one magazine to three or four guns: this is generally a rectangular pit, sunk to about three feet below, with sides and a roof of timber rising about as much above, the natural ground: the roof is covered with earth of a thickness which may be capable of resisting the momentum of a shell, and the descent to the floor of the magazine is by an inclined plane towards the rear. *Traverses*, or elevations of earth, revetted at the sides generally by gabions, are formed at intervals in the interior of the battery, to afford protection for the men against such shot or shells of the enemy as may fall there.

Howitzer and mortar batteries are executed nearly in the same manner as the others, except that mortar batteries never have embrasures, and the embrasures of a howitzer battery are made of a peculiar shape. [EMBRASURE.]

Some further particulars of batteries will be found under SIEGE.

BATTLE-AXE, a military weapon of offence used in different countries from the remotest times. Sir Samuel Meyrick says, as it was suggested by, so it immediately followed, the invention of the hatchet. The two Greek names for the battle-axe, ἀξίνη (*axíne*), and πέλεκυς (*pélekus*), occur in Homer in the same verse, 'Il.' O. l. 711. What was the precise difference between the two weapons we are not told by ancient writers, but it seems probable that the *axine* was similar to our hatchet, while the *pelekus*, which is usually translated in Latin by *bipennis*, had evidently two heads or edges; for Homer mentions another instrument of the same kind in the 23rd book of the 'Iliad,' called Ἡμιπέλεκον (*hemipelekon*), or the half-axe. Suidas interprets Ἡμιπέλεκα (*hemipeleka*), by αἱ μονόστομοι ἀξίναι, one-edged axes. (See Kuster's note on Ἡμιπέλεκα.) The *pelekus*, or *bipennis*, was also called *securis Amazonica*, the Amazonian axe, from its being supposed to have been used by those female warriors. The best representation of the ancient form of this *bipennis* is probably to be found in Petit's 'Dissertatio de Amazonibus,' 8vo, Amst., 1687, where it appears on the reverse of a coin of Thyatira, as well as upon the reverses of two coins of Marcus Aurelius. Numerous other coins of great antiquity bearing the *bipennis* are referred to in Rasche's 'Lexicon Rei Nummariæ,' tom. i. col. 502, et seq.; 'Supplem.' tom. i. p. 596.

Among the nations and tribes who joined the great expedition of Xerxes, we find battle-axes among the Sacæ (Herodot. vii. c. lxiv.), and the Egyptians (ibid. c. lxxxix.) Brennus, at the siege of the Roman capitol by the Gauls, was armed with a battle-axe. The Vindelici fought against Drusus with the battle-axe. (Horat. 'Carm.' iv. 4.) Tacitus, speaking of a later period ('Hist.' ii. 42), describes Otho's forces as cutting through helmets and breastplates with their swords and axes (*gladiis et securibus*). In the Roman armies, however, we do not find the battle-axe in ordinary use. It seems to have been considered as the weapon more peculiarly used by uncivilised nations. Ammianus Marcellinus (fol. Par. 1681, lib. xix. c. vi.), under the year 359, describes a body of Gauls as furnished with battle-axes and swords.

The introduction of the battle-axe into this country has been

frequently attributed to the Danes; but proofs of an earlier use of it in our islands are deducible. Mr. Hayman Rooke, in a memoir printed in the 'Archæologia' of the Society of Antiquaries, has engraved a fragment of a battle-axe found among some Druidical remains at Aspatria in Cumberland, in June 1789 ('Archæol.' vol. x. p. 113); and in the same volume (pl. xl.) are two representations of the old Galwegian bill or battle-axe, each two feet six inches long, found in a moss near Terreagles. Remains of others are stated to have been found among the barrows on the downs of Wiltshire, and in the north of Scotland. The Saxons used an axe with a long handle, which they called a bill; this continued long in use, and became the pole-axe and bill-hook of modern times: they had also the double-axe, or twy-bill. The Danes and Norwegians, however, probably made more use of this instrument than any other nations of their time. That the battle-axe was used in England in the Saxon times, we have the authority of different MSS. of the 9th century, and the English are represented as using it, in the Bayeux tapestry. Axe-heads of flint and of bronze have been found in many of the tumuli opened in various parts of this country; and others of a similar kind in those of Denmark (see the 'Archæologia,' and the Journals of the Archæological Association, and Institute, *passim*, Akerman's 'Archæological Index,' and Worsaae's 'Primeval Antiquities of Denmark,' translated by Thoms).

At the battle of Stamford Bridge, between Harold of England and Harold Harfager of Norway, when the Norwegians gave way and the English pursued them, a total stop is stated to have been put to the pursuit for some hours by the desperate boldness of a single Norwegian, who defended the pass of the bridge with his battle-axe. He killed more than forty of the English, and was himself at last slain only by stratagem. (Hen. Huntingt. l. vii. 211.) Ware, who wrote in the time of Henry II., mentions the gisarme (a word spelt in a variety of ways by different writers), which seems to have been a species of double-axe, with a cutting weapon projecting beyond the transverse points of the axe.

When King Stephen was taken prisoner by the Earl of Gloucester, we are told by Gervas of Canterbury that he had broken his battle-axe in pieces before he took to his sword, and was even then brought down by a stone. (Script. x. Twysd. col. 1354.)

During the middle period of English history we read but little of this weapon, though it appears to have been constantly used. The Welsh infantry at the battle of Agincourt, in 1415, found it particularly serviceable in despatching those whom the archers had wounded with their arrows. In Strutt's 'Manners and Customs of the English,' vol. ii. pl. xliv., Henry V. is represented as setting Richard, Earl of Warwick, to keep Port Quartervyle, at the siege of Rouen, by the delivery of a battle-axe.

Toward the close of the 16th century, the battle-axe, as a weapon of war, seems to have fallen into gradual disuse; although the occasional placing of a pistol in its handle, in some specimens which remain, seems to bespeak a wish on the part of the warriors of that period that it should be retained with an improved use.

Grose, in his 'Military Antiquities,' vol. ii. pl. xxviii. fig. 4, and pl. xxxiv. fig. 3, has engraved a Lochaber axe and an ancient battle-axe. Sir Samuel Meyrick, in his engraved illustrations of ancient armour now at Goodrich Court in Herefordshire, pl. lxxxiii., has engraved numerous specimens of battle-axes and pole-axes, from the time of Henry VI. to one of the year 1685, which is of Dutch origin, bearing the date, and the handle being ornamented with ivory.

The battle-axe was used at a very early period in naval fights, chiefly to cut the ropes and rigging of vessels. (See Scheffer, 'Mil. Nav.' ii. 7.)

BATTLE, WAGER OF. [APPEAL.]

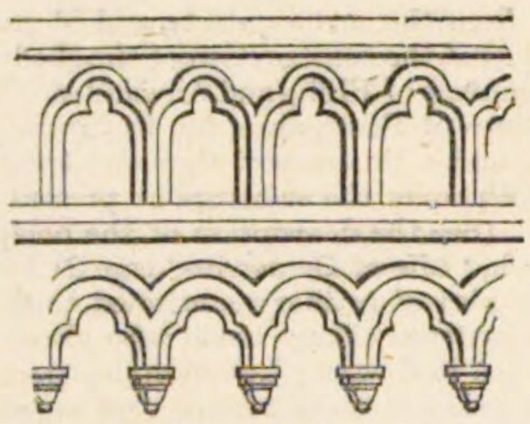
BATTLEMENT, a parapet wall, usually indented, originally intended for the protection of soldiers in military works; but in Gothic architecture, and especially English Gothic, commonly employed in ecclesiastical as well as castellated edifices. [GOTHIC ARCHITECTURE.] The battlements are of very remote antiquity, as remains of them still exist in Greece and Italy (see Mazois' 'Ruines de Pompeii,' and Stuart's 'Athens'); and they are represented in Egyptian paintings and Assyrian sculpture. The modern battlement, however, is better known as belonging to buildings from the 11th to the end of the 16th century; but it was not in general use in ecclesiastical edifices until the middle of the 12th century.

The battlement is generally indented, with a coping sloping both ways from about the centre; the lower part, between the coping and the cornice of the building, is often pierced and decorated. Although by the word battlement is generally understood the whole indented parapet wall, the term may perhaps with more propriety be applied to express rather the higher part of the wall, in contradistinction to the indent, interval, or embrasure. It is possible that the term battlement may have derived its name from the facility afforded to soldiers of doing battle under the protection afforded by the higher part of the indented wall. Battlements offer in their proportions, and in the details of their mouldings and ornaments, a great variety of examples.

Few Norman battlements remain. Usually, during the Norman period, the battlement seems to have been a plain parapet without intervals; and, if decorated, the decoration probably consisted of the semicircular arch, the peculiar feature of the Norman style. The

upper part or rim of a Norman font, decorated with semicircular-headed panels, in South Hayling Church, Hampshire, appears to be an imitation of such a parapet. The Norman church of l'Abbaye aux Dames, at Caen in Normandy, has a parapet decorated with pointed-arched-headed panels, which at the introduction of the pointed-arch style most probably supplanted the old semicircular-arched panel, similar to that at Hayling Church.

During nearly the whole period of the First Pointed, or Early English style, the parapet was seldom indented; and in many buildings it was plain, in others decorated. At Salisbury, it is executed with a series of arches and panels, and in Lincoln Cathedral with quatrefoils in sunk panels. A battlement of equal intervals occurs in small orna-



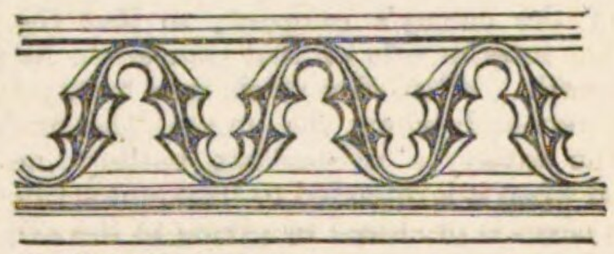
Battlement.

Trefoiled arches and corbels under battlement.

[Salisbury Cathedral.]

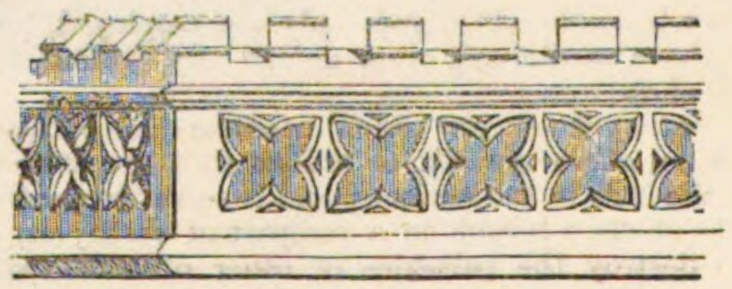
mented works erected about the close of this period, when this First Pointed or Early English style gave way to the Second Pointed, or as it is ordinarily denominated, the Decorated English style.

During this Second Pointed period, the parapet wall without indentations continued frequently to be used; but it is often pierced through in various forms, generally consisting of quatrefoils, and quatrefoils in circles. Another form, however, which is not so common, may be considered more beautiful. This is a waved line, the spaces of which are trefoiled. In St. Mary Magdalen Church, at Oxford, there is a



[Mary Magdalen College, Oxford.]

good example of this kind of battlement. Of the plain battlements, that which was most in use in this period has the embrasures or intervals narrow, and is surmounted with a capping moulding placed in a horizontal position as at Waltham Cross; but there are some

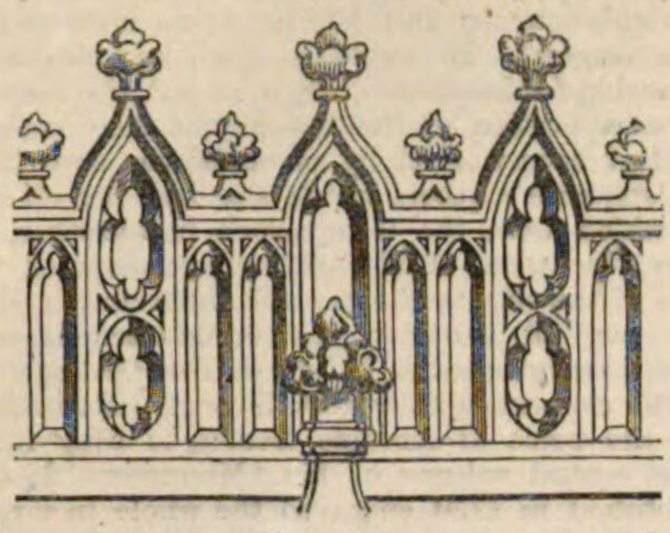


[Waltham Cross, as restored from the ancient fragments, by W. B. Clarke.]

battlements of the same date with the capping running both vertically and horizontally, of which there is a fine specimen in the tower of Merton Chapel, Oxford. In some small works of this style a flower is occasionally used as a finish above the capping, moulding, or cornice, but it is by no means common. The nave of York Cathedral presents a fine example of the pierced battlement so prevalent during this period; it consists of arches or arched panels, trefoiled or cinquefoiled, and the interval is a quatrefoil in a circle; the whole is covered with a moulding running both horizontally and vertically.

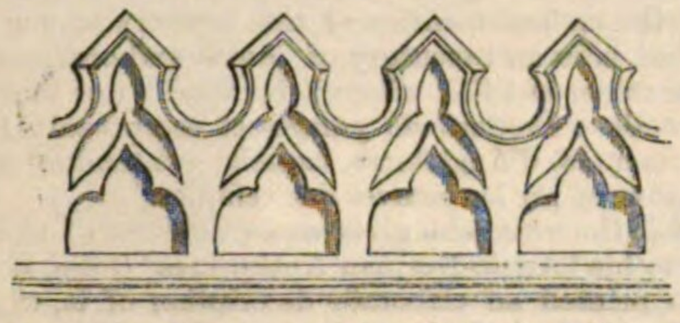
In the battlements belonging to the Third Pointed or Perpendicular style, parapets without indentures still continued to be used occasionally; the serpentine line with the trefoil was also still in use, but the line dividing the trefoil was more frequently made straight, and the divisions were consequently formed into triangular panels. But in the early and best works, the trefoils are not divided by straight lines. One of the finest examples of panelled parapets is at the Beauchamp Chapel, at Warwick, consisting of quatrefoils in squares, with shields and flowers. There are many varieties of pierced battlements belonging to this period. Those erected in the early part of it have commonly quatrefoils, either in the lower compartments or above the panels of the lower compartments, forming part of the higher panels. Two heights of panels are also frequently employed in battlements of this period. At Loughborough there is an example of a fine battlement, consisting of rich pierced quatrefoils in two heights. Such battlements have generally a moulded cornice running round the battlement and the embrasure. A few edifices of a later period have pierced battlements ornamented with pointed compartments, as in the tower

of Lincoln Cathedral, the Tomb-house at Windsor, the Lady Chapel at Peterborough, and the great battlement at King's College Chapel, Cambridge. Sometimes on the exterior of a building, and often within, the Tudor or three-leaved flower, forming a point at the top, is used



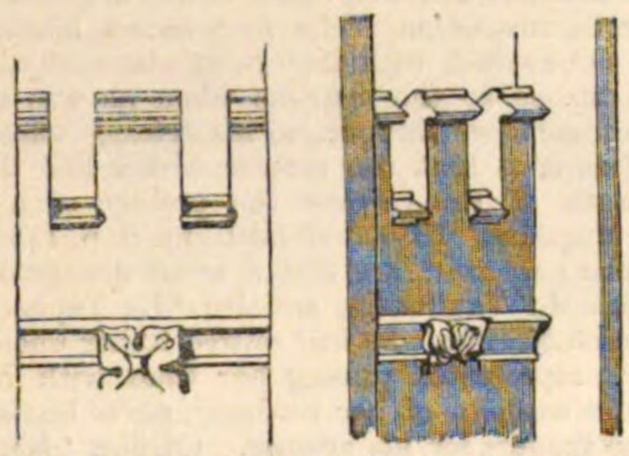
[From the tower of Lincoln Cathedral, from a sketch by G. Moore, Arch.]

on the battlement, as at the screens in the choir of Exeter Cathedral; and there are a few instances of the upper part of a battlement analagous in form to it, in small works erected long before this date—as at Northampton Cross. But Waltham Cross, erected at the same



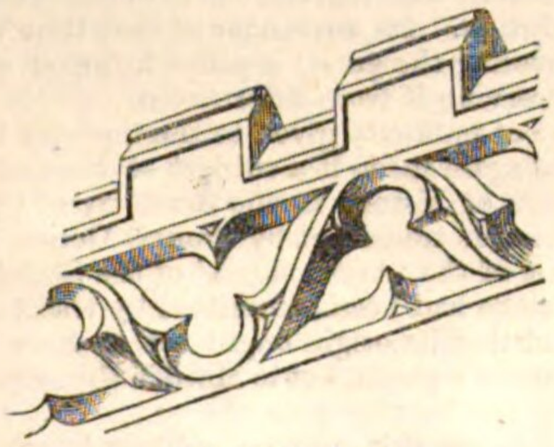
[Northampton Cross, from an original sketch by G. Moore, Arch.]

time, is without this finish. Some battlements of this period, especially in very rich designs, have, in lieu of the Tudor flower, a finial on the top of pierced quatrefoils, as at Woolpit and Blithborough Churches in Suffolk and Norfolk. Of plain battlements in the Perpendicular style there are many varieties. Some are formed with nearly equal intervals, and with a plain coping placed both horizontally and vertically. Castellated battlements have the embrasures between the battlements nearly equal to the width of the battlements themselves; sometimes



[Turret of King's College Chapel, Cambridge.]

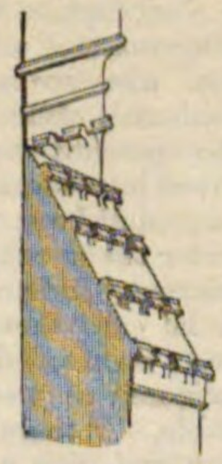
they have wide battlements and narrow embrasures, with the coping moulding placed horizontally, and the sides cut plain. Another battlement consists of a moulding running round the battlement and the embrasure, while a capping is set upon the horizontal part of the embrasure and battlement, as at York Minster. The most common



[York Minster.]

battlement towards the close of this period has a broad cornice, consisting of several mouldings, running both vertically and horizontally, the embrasures being very often much narrowed and the battlement enlarged.

The battlement, which was originally designed for the protection of the besieged, became afterwards merely an ornament to an edifice; being used as an ornament to the transoms of windows, and in other curiously inappropriate positions. A most remarkable example of the



[Buttress, with battlements, at Loddon Church, Norfolk.]

excessive use of it as a decoration is shown in the annexed cut, representing the top of a buttress at Loddon Church, Norfolk.

BAXTERIANS, a name which is applied to those who adopt the theological system of Richard Baxter. The name is now almost extinct; but Baxterianism is still the resting place of many who do not approve of the extremes of Calvinism. The Baxterians hardly ever attained the rank of a separate denomination, even when they were most numerous; and they are now completely scattered among different communions. Their writings are most popular among the orthodox dissenters.

Baxterianism occupies a sort of middle place between Arminianism and Calvinism. It is not correct to say that it reconciles the two schemes. It only connects them by showing that portions from each may be made to harmonise with each other. Hence it would be more properly described as a system of theology framed out of the systems of Calvin and Arminius, and becoming itself the point of union between them. Its chief merit is supposed to consist in the amalgamation of the Arminian doctrine of free grace with the Calvinistic doctrine of election. The Baxterians profess to believe that a certain number, determined upon in the divine counsels, are elected to salvation without respect to their good works. To this extent they receive the doctrine of effectual calling. But to make their view of the operation and comprehensiveness of divine favour complete, they contend that all to whom the gospel is preached are placed in a condition for securing their own salvation. Hence they think with Calvin that Christ died in a special manner for the elect; and, in a more general sense, for all others who come within the light of the gospel. The Calvinistic tenet of reprobation forms no part of their system.

The grounds on which Baxter contended that the death of Christ put all men in a state of salvation are briefly these: 1st, Because Christ assumed the human nature, and bore the sins of the human race; 2nd, Because pardon and life were offered to all mankind on condition of acceptance,—"Whosoever believeth shall be saved;" and, 3rd, Because it is not to the elect alone, but to all men, that the benefits of the gospel are proclaimed.

The arguments by which the learned divines of this school prove the elect to have a superior interest in the death of Christ over the non-elect, are deeply tinctured with that metaphysical subtlety of which Bishop Burnet complains as the great blemish of Baxter's writings. The hypothesis, in a few words, may be thus stated: that Christ has made a conditional gift of the benefits accruing from his death to all mankind; but to the elect the gift is absolute and irreversible; from which he draws the inference that, notwithstanding the *positive* possession of these advantages was decreed to the few, yet conditionally the benefit was extended to all.

The Baxterians are greatly opposed to Antinomianism. Faith without works they hold to be an unscriptural and dangerous tenet. Several of the minor doctrines of Calvinism are adopted in a modified sense, among which may be mentioned justification and the perseverance of the saints. They advocate the certainty of perseverance, but incline to the opinion that it may be lost by too weak a degree of saving grace.

In all the Baxterian deviations from the system of Calvin there is a decided leaning to more comprehensive views. Baxter was himself opposed to the narrowing of the terms of salvation, and designed to remove every appearance of exclusiveness in the operation of divine favour from the system which he took such pains to adjust and promulgate. The most eminent divines who have embraced these opinions since the death of their author are Watts and Doddridge—men who have both illustrated in their works and lives the candid and amiable spirit of the school to which they belonged.

(Calamy's *Abridgment of Mr. Baxter's History of his Life and Times*, 2nd edit. 1713; Baxter's *Catholic Theology*; Buck's *Theological Dictionary*.)

BAY, in architecture, a division or compartment in a building formed by the main ribs of the vaulting, the principals of the roof; the main beams or arches, pillars, pilasters, or buttresses, or any other principal features which divide the building into corresponding compartments. The space between the mullions of a window is also sometimes, but improperly, called a bay: it is more correctly called a light.

BAY-SALT. [SALT.]

BAY WINDOW. [ORIEL.]

BAYADEER (said to be a corruption of *Bailadeira*, a Portuguese word, which signifies a dancing woman), a name given to the regularly-bred dancing girls in India, who are also the regular prostitutes. Among the Hindu Brahmins, female children are devoted, before their births, under a vow of the parents, to the service of the deity Mahadeo, and these are received into some of his temples. They are brought up in the usual accomplishments, and the wages of their exertions and their infamy enter the treasury of the temple with which they are connected. Mr. Maurice ('Indian Antiquities') says that the priests of these pagodas, as he calls them, induce young females to enter, that every pagoda has a band of them, who dance before the idol, to whom they are considered as wedded, and that they are not considered as at all disreputable. If there is any offspring from their promiscuous intercourse, boys and girls are both considered as consecrated to the idol: the boys are taught to be musicians for the festivals; the girls have to lead a similar life to their mothers. Bernier's account, of a much earlier date, is of a like character. The Mohammedans of India have also their dancing-girls, of the same character, but who are generally provided by women who make it their business to select handsome children, teach them the necessary accomplishments, and subject them to the same infamous life; but though called bayadeers, they are not devotees of the temples.

These girls are generally introduced to any party that requires their attendance, escorted by a band of musicians. A native band consists of instruments resembling guitars, and others like clarionets, with cymbals and kettle-drums, which altogether produce a very wild, but not an unpleasing, and a somewhat melancholy harmony. The women dance and sing; and when one is desired to dance, she calls for the ornaments of her feet, which consist of silver chains, which she fastens on her ancles. Then, rising from the ground, she arranges her dress, which generally consists of about a hundred yards of light muslin, which terminates in innumerable folds at about the swell of the leg; and of a shawl which covers part of the head, comes over the shoulders, and falls in folds over the petticoat. The hair is seldom ornamented, but is parted in the middle, and kept close down by the aid of the cocoa-nut, which improves its jet and gloss, but communicates an unpleasant odour. Behind the ears a bunch of pearls is worn like a cluster of grapes, and a ring is suspended from one of the nostrils, through which it is inserted. The ornaments however are sometimes more and sometimes less numerous and costly than this.

The dancing consists in a certain methodical kicking of the right foot, which causes the chains on the ancles to jingle in unison with the music; the dancer now advancing, then retreating; sometimes with the hands up, and twisting them about; at others, enveloping her head completely in the shawl. The movements of the bayadeer are sometimes so slow in this performance that an inexperienced spectator might suppose her about to fall asleep, when, in correspondence with a change in the music, she becomes full of life, and exhibits a rapid and exhausting succession of violent action. She takes up her robe and folds it into various shapes; then she lets it go, so that while she spins round like a top it forms a circle, bearing some resemblance to the tail of a peacock. It is perfectly amazing for what a length of time practice enables them to maintain this circular motion. This part of the performance is sometimes dispensed with. In differents parts of the country these dances vary in the proprieties of dress and attitude. In some parts they are highly indecent, but this is not always, or perhaps generally, the case. The songs of the bayadeers however commonly express, in very warm language, the sentiments of amorous passion, as addressed by the female to her lover. Such songs afford a striking contrast to those of the Persians, who, according to Sir William Ouseley, "never suffer their females to make, either in prose or verse, any advances or declarations of love."

(Heber's *Narrative of a Journey, &c.*; Ouseley's *Travels in various Countries of the East.*)

BAYEUX TAPESTRY, a web or roll of linen cloth or canvass, preserved in the Hôtel de Ville, Bayeux, in Normandy, upon which a continuous representation of the events connected with the invasion and conquest of England by the Normans is worked in woollen thread of different colours, in the form of a sampler. It is 20 inches wide, and 214 feet long: and is divided into seventy-two compartments, each bearing a superscription in Latin which indicates its subject, or the person or persons represented. It is edged on its upper, as well as its lower part, by a border representing chiefly quadrupeds, birds, sphinxes, minotaurs, and other similar subjects. Mr. Bruce states that "it contains figures of 623 men, 202 horses, 55 dogs, 505 animals of various kinds not already enumerated, 37 buildings, 41 ships and boats, and 49 trees—in all 1512 figures."

Attention was first directed to this singular monument by M. Lancelot, in a memoir presented to the Academy of Inscriptions and Belles Lettres, in 1724, in consequence of his discovering an illuminated drawing from a portion of it, among the manuscripts in the library of M. Foucault, who had been Intendant of Normandy. At the time of finding it, he did not know what it actually represented; whether the original was a sculpture round the choir of a church, upon a tomb, or on a frieze; whether it was a painting in fresco, or on glass; or, lastly, whether it might not be a tapestry. He saw that it was historical, and that it related to William Duke of Normandy and the conquest of England; and he wrote to Caen respecting it, but got no information.

Père Montfaucon, upon reading Lancelot's memoir, saw the value of this curious representation, and left no stone unturned till he had discovered the original. He wrote to Caen and Bayeux, and sent a copy of the drawing for inspection, when, at last, the canons of Bayeux recognised it as a portion of the tapestry in their possession, which tradition said had been worked by, or under the superintendence of, Matilda, the Conqueror's queen, which she had herself given to the cathedral, of which Odo, the Conqueror's half-brother, was bishop, and which they, the canons of Bayeux, were accustomed to exhibit to the inhabitants of the city, in the nave of their church, at a particular season of the year. M. Lancelot, in a second memoir, says it was at that time traditionally called *la Toilette de Duc Guillaume*, a name by which it is still commonly known at Bayeux. Montfaucon sent an able artist, of the name of Antoine Benoit, to copy it; and at the opening of the second volume of his 'Monumens de la Monarchie Françoise,' published in 1730, engraved the whole in a reduced form, accompanied with a commentary upon the Latin inscriptions, which, throughout, explain the intention of the figures represented in the different compartments.

M. Lancelot, upon the publication of the tapestry by Montfaucon, sent a second memoir to the Academy of Inscriptions and Belles Lettres (as has been just mentioned), which was read in 1730, and published in the same year, in the eighth volume of their transactions, in which he states that the earliest mention of this tapestry among the archives of the cathedral is in an inventory of jewels and ornaments belonging to the church, taken in 1476, where it is called "une tente très longue et étroite de telle à broderie de ymages et eserpteaulx faisans representation du conquest d'Angleterre, laquelle est tendue environ la nef de l'Eglise le jour et par les octaves des reliques."

Dr. Ducarel is the next who gives us an account of this tapestry, in the appendix to his 'Anglo-Norman Antiquities' (folio, London, 1767), where he has printed an elaborate description of it, which had been drawn up some years before, during a residence in Normandy, by Smart Lethieullier, Esq., an able English antiquary. Ducarel tells us that when he was in Normandy it was annually hung up on St. John's day, and went exactly round the nave of the church, where it continued eight days. At all other times it was carefully kept locked up in a strong wainscot press in a chapel on the south side of the cathedral.

From this time till the autumn of 1803 it received but little further notice, when Bonaparte, then first consul of France, contemplating the immediate invasion of England, ordered it to be brought from Bayeux to the National Museum at Paris, where it was deposited during some months for public inspection. The first consul himself went to see it, and affected to be struck with that particular part which represents Harold on his throne at the moment when he was alarmed at the appearance of a meteor which presaged his defeat,—affording an opportunity for the inference that the meteor which had then been lately seen in the south of France was the presage of a similar event. ('Gentleman's Magazine,' 1830, vol. lxiii., pt. ii. p. 1136.) The exhibition was popular: so much so, that a small dramatic piece was got up at the Theatre du Vaudeville, entitled 'La Tapisserie de la reine Mathilde,' in which Matilda, who had retired to her uncle Roger during the contest, was represented passing her time with her women in embroidering the exploits of her husband, never leaving their work, except to put up prayers for his success. (Millin, 'Magazin Encyclopédique,' 1803, tom. iv. p. 541.) After having been exhibited in Paris, and in one or two large towns, the tapestry was returned to Bayeux, and lodged with the municipality. Mr. Dawson Turner, in his 'Tour in Normandy,' written in 1818, says, the bishop and chapter of Bayeux had then recently applied to the government for the tapestry to be restored to their cathedral, but without effect. ('Tour in Normandy,' 8vo, Lond., 1820, vol. ii. p. 242.)

It was most fortunate that this curious monument escaped destruction during the Revolution. Its surrender at that time was demanded for the purpose of covering the guns; a priest however succeeded in concealing it and preserving it from destruction.

The new degree of publicity given to the tapestry by its exposure in the French capital again made it a subject of discussion; and the Abbé de la Rue, professor of history in the Academy of Caen, endeavoured, in a memoir, afterwards translated by Francis Douce, Esq., and printed in the 17th volume of the 'Archæologia' of the Society of Antiquaries, to show that a mistake had been committed by tradition in the selection of the Matilda, and that its origin ought not to have been ascribed to Matilda the Conqueror's queen, but to Matilda the empress, the daughter of King Henry I.

The next memoir on this curious subject is comprised in a short letter from Mr. Hudson Gurney, printed in the 18th volume of the 'Archæologia,' who saw the tapestry at Bayeux in 1814, where it then went by the appellation of the *Toile de St. Jean*, which is explained by what Ducarel has said, that it was formerly exhibited upon St. John's Day. Lancelot, Montfaucon, Ducarel, and De la Rue, appear all to have considered the tapestry as a monument of the Conquest of England, intended to have been continued to Duke William's coronation, but from some cause or other left unfinished. Mr. Gurney

considered it to be an apologetical history of the claims of William to the crown of England, and of the breach of faith and fall of Harold; and that, as it stands, it contains a perfect and finished action.

In the mean time, the Society of Antiquaries in 1816 despatched an excellent and accurate artist, Mr. Charles Stothard, to Bayeux, who, in that and the succeeding year, brought home a perfect fac-simile of the tapestry, the drawings of which have been since engraved, coloured like the original, and published in the 6th volume of the 'Vetusta Monumenta,' plates i. to xvii.

The appearance of the first portion of Mr. Stothard's drawings gave rise to some Observations from Mr. Amyot, in refutation of an historical fact which the tapestry had been supposed to establish; namely, that of Harold's mission to Normandy by the Confessor to offer the succession to William. ('Archæol.' vol. xix. p. 88.) These were followed by C. Stothard's own observations while at Bayeux, pointing out such circumstances as presented themselves to his notice during the minute investigation to which the tapestry was necessarily subjected (Ibid. vol. xix. p. 184), and again followed by 'A Defence of the early antiquity of the Tapestry,' by Mr. Amyot (Ibid. p. 192), in which the objections raised by the Abbé de la Rue against the tradition which made the tapestry coeval with the events it celebrates, are completely invalidated.

The work begins with the figure of a king seated upon his throne, who is addressing one of two persons standing by his side: the inscription is simply 'EDWARD REX.' It appears to be Harold taking leave. We next see Harold proceeding to Boseham attended by several followers; he carries a hawk upon his fist, at that time the distinguishing mark of nobility; his dogs are running before him: 'IBI HAROLD DVX ANGLORVM ET SVI MILITES EQVITANT AD BOSHAM.' A church is then represented, in front of which are two men who appear about to enter: above is the word 'ECCLESIA.' This church is Boseham in Sussex. The party next appear feasting at a table in a house, previous to their embarkation. Some persons are descending the steps from the apartment where they have been dining; others are embarking in four vessels. Harold enters first, still bearing the hawk and carrying a dog under his arm. These last-mentioned figures are wading through the water, naked from the waist downwards: 'HIC HAROLD MARE NAVIGAVIT ET VELIS VENTO PLENIS VENIT IN TERRAM WIDONIS COMITIS.' The last of the four vessels next appears anchoring in France, Harold standing at the prow: his name 'HAROLD' above. Three figures are then represented upon land; one of them is Harold in the act of being seized by order of Guy Earl of Ponthieu, who is on horseback, followed by his people: 'HIC APPREHENDIT WIDO HAROLDVM ET DVXIT EVM AD BELREM ET IBI EVM TENVIT.' Harold and Guy are next seen mounted upon their horses, and attended both by Saxon and Norman soldiers. The Saxons are distinguished by wearing mustachios; the Normans have none. Harold and Guy appear in conversation, 'VBI HAROLD ET WIDO PARABOLANT:' when messengers arrive from William Duke of Normandy to the Earl of Ponthieu 'VBI NVNTII WILIELMI DVCIS VENERVNT AD WIDONEM.' Between the Earl of Ponthieu who is seated, and his guards who receive the messengers, a tree divides the subject, as other trees, in like manner, divide all the principal events throughout the work. A dwarf, with the name of 'TVROLD' above, holds the horses of Duke William's messengers. William's messengers are again represented on horseback, bearing shields; 'NVNTII WILIELMI.' Next is a Saxon messenger mustached, kneeling to William on his ducal seat: 'HIC VENIT NVNCIVS AD WILGELMVM DVCEM.' Guy is seen immediately after, conducting Harold to the duke: 'HIC WIDO ADDVXIT HAROLDVM AD WILGELMVM NORMANNORVM DVCEM.' William meets them, and returns with Harold to his palace: 'HIC DUX WILGELM CVM HAROLDO VENIT AD PALATIUM SVVM.' We have then a female figure within the door of a church, and a priest, and beneath them the words 'VNVS CLERICVS ET ÆLFGYVA.' Mr. Douce says evidently Adeliza, William's daughter, who was affianced to Harold. The next event is William's warfare with Conan Earl of Bretagne, in which it is apparent Harold assisted and rendered essential service to the Norman party: 'HIC WILLEM DVX ET EXERCITVS EIVS VENERVNT AD MONTEM MICHAELIS.' Soldiers, mounted on horseback, arrive at Mount St. Michael and pass the river Cosno: 'ET HIC TRANSIERVNT FLVMEN COSNONIS ET VENERVNT AD DOL.' Harold is depicted among them, assisting some persons who had fallen into the quicksands while passing the river: 'HIC HAROLD DVX TRAHEBAT EOS DE ARENA.' We have then the words 'ET CONAN FVGA VERTIT.' Conan is seen escaping from Dol and descending the walls by a rope. Troops are flying and approach Rennes: 'REDNES.' The Norman soldiers are next employed in attacking Dinant: 'HIC MILITES WILLELMI DVCIS PVGNANT CONTRA DINANTES.' Conan delivers up to them the keys of the town, which they succeed in taking: 'ET CVNAN CLAVES PORREXIT.' After this event William rewards the services of Harold by giving him a suit of armour: 'HIC WILLELM DEDIT HAROLDO ARMA.' William and his party then arrive at Bayeux; 'HIC WILLELM VENIT BAGIAS.' Is is said that William, in order to secure to himself the succession of the Saxon throne, without having Harold for a competitor, caused him to take a solemn vow that he would never attempt the possession of the English crown: this vow he obliged Harold (then within his power) to make upon a covered altar, beneath which William had placed the most sacred and precious relics. No sooner had Harold

sworn the oath, than the Norman duke uncovered the altar, and by showing him what sacred things he had vowed, enforced upon his mind the blasphemy he would be guilty of, if he ever attempted the violation of his oath. Harold is represented taking the oath, while standing between two covered altars: 'VBI HAROLD SACRAMENTVM FECIT WILLELMO DVCI.' Harold next embarks for England: 'HIC HAROLD DVX REVERSVS EST AD ANGLICAM TERRAM ET VENIT AD EDWARDVM REGEM;' and is immediately after represented as relating the events of his journey to the Saxon king.

The next subject is the death and funeral of Edward the Confessor. The funeral procession comes first: 'HIC PORTATVR CORPVS EADWARDI REGIS AD ECCLESIAM PETRI APOSTOLI.' The king is then represented in his bed, giving his last directions to the officers of his court: his wife Editha weeping by his side: 'HIC EADWARDVS REX ALLOQVIT FIDELES.' Beneath he is represented dead and laid out: 'ET HIC DEFVNCTVS EST.' The next subject is the crown offered to Harold by the people: 'HIC DEDERVNT HAROLDO CORONAM REGIS.' Harold then appears upon his throne, Stigand, Archbishop of Canterbury, at his side: 'HIC RESIDET HAROLD REX ANGLORVM. STIGANT ARCHIEPISCOPVS.' The subject that follows is the appearance of a comet, at which the people are gazing: 'ISTI MIRANT STELLAM.' Harold is seen below it, listening to a person who has approached him: his name above, 'HAROLD.' Boats are represented in the border beneath. The next subject which the tapestry represents is a ship, bringing to William the news of Harold's having assumed the English crown: 'HIC NAVIS ANGLICA VENIT IN TERRAM WILLELMI DVCIS.' William and his half-brother, Odo, bishop of Bayeux (distinguishable by the tonsure), appear consulting together and giving orders that ships should be built for the purposed invasion of England: 'HIC WILLELM DVX IVSSIT NAVES EDIFICARE.' Accordingly several persons are next represented as employed in cutting down trees; carpenters are constructing vessels, and others draw them into the sea: 'HIC TRAHVNT NAVES AD MARE.' The embarkation of the Normans forms the succeeding subject; they carry with them on board the ships wine, arms, and provisions: 'ISTI PORTANT ARMAS AD NAVES ET TRAHVNT CARRVM CVM VINO ET ARMIS.' William going to his own vessel is next represented: 'HIC WILLELM DVX IN MAGNO NAVIGIO.' Numerous ships are then seen passing the sea, loaded with troops and horses, and William arrives in Pevensey bay (his own vessel known by the figure of a boy holding a pennon at the stern; it bears a lantern at the mast): 'MARE TRANSIVIT ET VENIT AD PEVENESÆ.' The troops and horses next appear disembarking: they proceed to Hastings, where they seize provisions: 'HIC EXEVNT CABALLI DE NAVIBVS ET HIC MILITES FESTINAVERVNT HASTINGA VT CIBVM RAPERENTVR.' A figure on horseback, bearing a pennon at the end of his lance, is here distinguished by the words 'HIC EST WADARD.' The Normans are now busied in cooking meats and regaling themselves: 'HIC COQVITVR CARO ET HIC MINISTRAVERVNT MINISTRI. HIC FECERVNT PRANDIVM.' The soldiers dine upon their shields. Odo seated at a table, with William on his right hand, bestows his benediction on the viands: 'ET HIC EPISCOPVS CIBVM ET POTVM BENEDICIT.' William, with Odo and Robert Earl of Mortaigne, are seated under a canopy: 'ODO EPISCOPVS. WILLELM. ROTBERTVS.' A figure carrying a pennon then appears giving orders that the army should encamp at Hastings: 'ISTE IVSSIT VT FODERETVR CASTELLVM AT HESTENGA.' The camp forming: 'CASTRA.' William appears directing the building of a castle. The news is then brought to William that Harold is advancing to oppose the Normans; William on a raised seat: 'HIC NVNTIATVM EST WILLELMO DE HAROLD.' Two Normans setting fire to a house; a woman and child escaping from it: 'HIC DOMVS INCENDITVR.' The soldiers of William leave Hastings to meet Harold in the field; and the duke now, for the first time since his arrival, appears in armour: the march of the horsemen: 'HIC MILITES EXIERVNT DE HESTENGA ET VENERVNT AD PRELIVM CONTRA HAROLDVM REGEM.' Odo is represented bearing a mace, but preceded by William on horseback with a club, who interrogates Vitalis, an individual of his army, also on horseback, whether he has seen Harold's forces: 'WILLELM DVX INTERROGAT VITAL. SI VIDISSET EXERCITVM HAROLDI.' Harold also receives information relative to William's force: 'ISTE NVNTIAT HAROLDVM DE EXERCITV WILLELMI DVCIS.' William then addresses his soldiers, who are proceeding onward to the battle: 'HIC WILLELM DVX ALLOQVITVR SVIS MILITIBVS VT PREPARARENT SE VIRILITER ET SAPIENTER AD PRELIVM CONTRA ANGLORVM EXERCITVM.' The Normans approach, mostly on horseback, but intermixed with archers on foot. The battle now ensues, in which the Saxons are chiefly on foot, their shields distinguished from those of the Normans by being usually round with a boss in the centre. Lewine and Gyrth, the brothers of Harold, are slain: 'HIC CECIDERVNT LEWINE ET GYRTH FRATRES HAROLDI REGIS.' The obstinacy of the contest is next represented: 'HIC CECIDERVNT SIMVL ANGLI ET FRANCI IN PRELIO.' Odo is now represented charging full speed and striking at a horseman with a club or mace: 'HIC ODO EPISCOPVS BACVLVM TENENS CONFORTAT PVEROS.' This probably means that Odo had to encourage the troops, upon a report that William was slain. The battle continues; 'HIC EST WILLELM DVX.' The duke appears showing himself and giving orders: 'HIC FRANCI PVGNANT ET CECIDERVNT QVI ERANT CVM HAROLDO.' The death of Harold, the standard carried before whom appears to be a dragon. We have then the discomfiture and flight of the Saxons. Here the tapestry ends with figures of persons retreating in great haste; not

complete in its ornamental work, but, in all probability, complete in its history.

This extraordinary piece of needle-work—for such it is, though called tapestry—is now preserved in the Hôtel de Ville at Bayeux. It used to be kept coiled round a machine, like that which lets down the buckets of a well, and exhibited by being drawn out at leisure over a table; but it is now kept under glass, in the public library. The coloured plates of it, published by the Society of Antiquaries, from the drawings of Mr. Charles Stothard, in the 4th volume of the 'Vetusta Monumenta,' will enable any one to form a very accurate notion of its actual appearance. Plates i. to xvi. represent the whole, one-fourth size of the original. The xviith plate gives a portion of the true size. Dibdin, in his 'Bibliographical Tour,' vol. i. p. 377, has engraved a view of it upon its machine. Thierry, in the Atlas of Plates to his 'Histoire de la Conquête de l'Angleterre par les Normands, cinquième éd.' 1839, has engraved a reduced fac-simile of the tapestry. It has also been engraved on a reduced scale, in colours, from the plates in the 'Vetusta Monumenta,' in 'The Bayeux Tapestry Elucidated,' by J. C. Bruce, LL.D., 8vo, Lond., 1855, the latest and most complete work on the subject.

It was long since decided by the French antiquaries, that this work is of the age of the Conquest, the Abbé de la Rue alone maintaining that it was executed in the time of our Henry I. Those persons however among the English antiquaries whose particular learning and knowledge render them competent judges of the authenticity of this tapestry, unite in the conviction that its own internal evidence corroborates the ancient tradition which the French antiquaries adopted. It represents the minutest manners and customs of the earliest Norman times in England; and was evidently designed while the particulars of the contest were known and fresh in recollection. It embraces several events of which no other record now exists, amongst which may be noticed the taking of Dinant, and the war between the Duke of Normandy and Conan, earl of Bretagne. Nor does any other notice exist of the service rendered by Harold to Duke William, during his war in Brittany. It is not a little remarkable, too, that in the compartment which represents the funeral procession of Edward the Confessor, a figure is portrayed placing a weathercock upon the spire of Westminster Abbey, indicating that the building was scarcely finished at the time of his decease. Ducarel, as we have already mentioned, says, that this tapestry, when exhibited at Bayeux, went exactly round the nave of the church.

Odo, it is to be remarked, makes the most conspicuous appearance, next to Duke William, of any Norman personage represented in the tapestry; and three figures, *Wadard*, *Turold*, and *Vital*, apparently unimportant personages, were really among the chief of those whom Odo brought into the field. Wadard and Vitalis, with the son of a person named Turold, are recorded, twenty years after the Conquest, among the under-tenants of Odo, as persons rewarded with lands, in the Domesday Survey. Wadard held property under the bishop in no fewer than six counties; Vitalis held lands under Odo in Kent; and the son of Turold in Essex. (Ellis's 'Introduction and Indices to Domesday,' vol. ii. p. 403.) These circumstances cannot but appear convincing, not only that the tapestry is of the age assigned to it by tradition, and was worked expressly for the bishop's cathedral, but render it very probable that it was a present from Matilda, the Conqueror's queen, as a grateful memorial of the effective service which Odo had rendered in the Conquest.

BAYONET. [ARMS.]

BAZAAR. The word *bazaar* is Persian, and its primary meaning is *a market, a forum*. In Turkey, Egypt, Persia, and India this term distinguishes those parts of towns which are exclusively appropriated to trade. In this exclusive appropriation they resemble our markets; but in other respects they approximate more nearly to our retail shops. We have interpreted the word in its large sense; for although the term bazaar is in this country commonly understood to mean an assemblage of shops or stalls under cover, yet in fact it equally applies to open places in which bulky commodities are offered for sale. Such places sometimes occur in eastern towns, and are used chiefly in the early morning, at least in summer, for the sale of vegetables and cattle. If a place in the open ground outside a town be commonly applied to this use, it will be called a bazaar, and will be distinguished, as in all other cases, by joining to the word "bazaar" the name of the commodity sold. In large towns, however, such markets are generally near or in the midst of the regular covered bazaars; except the market for cattle, which is always outside or at the extremity of the town. In some places bazaars are rather extensive squares, the sides of which are lined with shops under arcades. In a few cases the covered ways branch off with some regularity from these squares as from a centre: and in one of the best specimens of the open market, at Kermanshah in Persia, the palace of the prince-governor occupies one of its sides. When, however, as in this and some other instances, the principal open area in the city is thus appropriated, its distinctive appellation of the *Maidan*, or square, is retained.

The regular bazaars consist of a connected series of streets and lanes, and, when of a superior description, they are vaulted with high brick roofs. The domes or cupolas which surmount the vaulting admit a subdued daylight; and, as all direct rays of the sun are excluded, a comparatively low temperature is obtained. The description of a good bazaar in Persia is a description of a good bazaar in Turkey or India. Nevertheless, the Persian bazaars are rather more light and lively than those of Turkey. They are painted in many places, and sometimes decorated, particularly under the domes, with portraits of the heroes of the country, with representations of battles or hunts, with figures of real or fabulous animals, and with other subjects. The approaches to the bazaars are commonly lined with low shops, in which commodities of little value are exposed for sale. These approaches are sometimes open to the sky; but they are more generally covered in a rude manner with branches of trees, and leaves laid upon beams. In many of the provincial towns of Turkey and Persia, the bazaar, as a whole, would answer to this last description; and in others it is nothing more than a mud platform continued along the wayside, about two feet above the footpath, on which little covered shops are raised, that are mere boxes, scarcely affording room for the vendor to sit down on a bit of carpet or felt in the midst of his scanty stock.

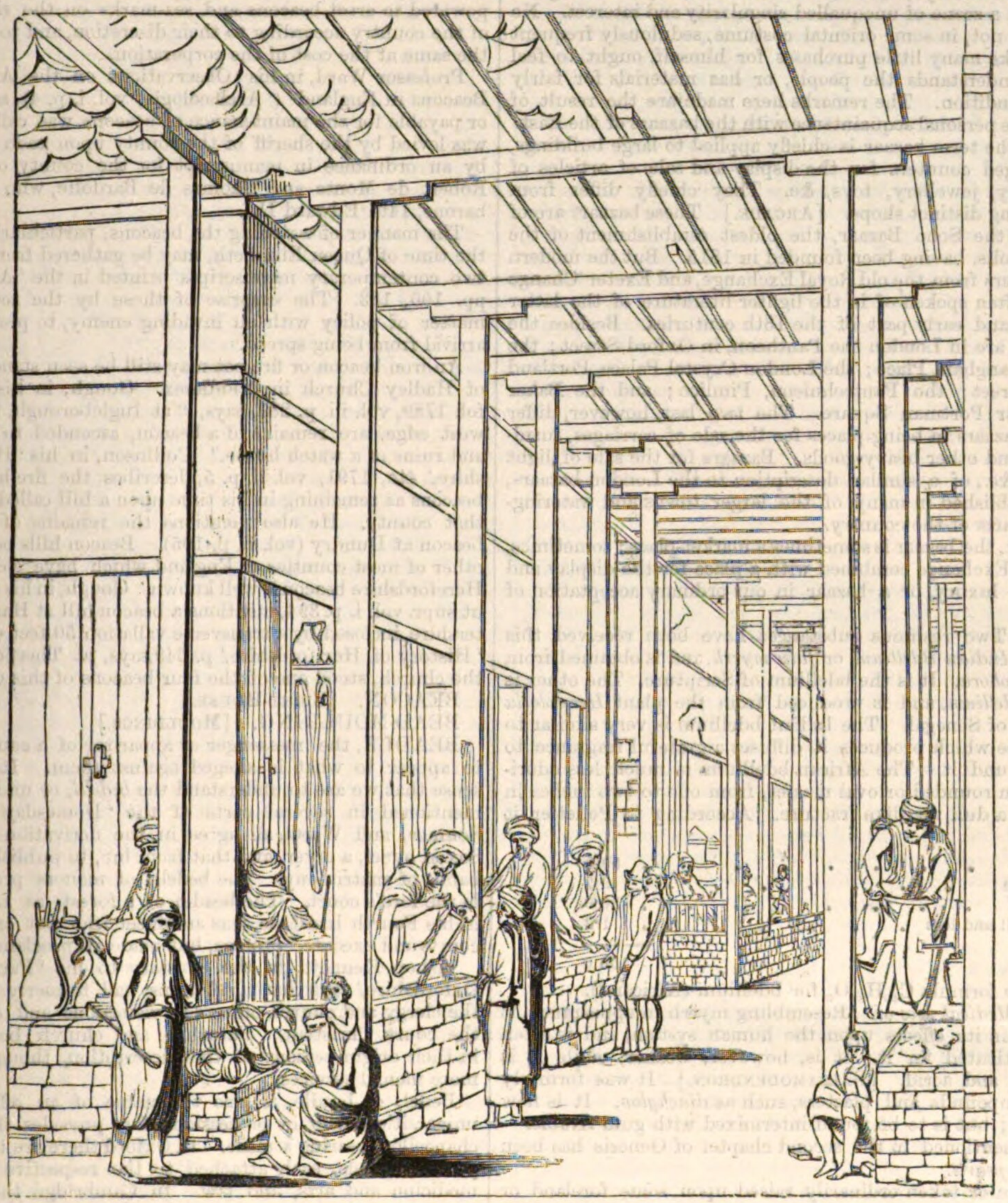
In the best specimens of the vaulted bazaar the passages are lined on each side with a uniform series of shops, the floor of which is a platform raised from two to three feet above the level of the ground, and faced with brick. As the vault springs from the front of the line of shops, they seem like a series of recesses, and the partition-walls between them appear like piers supporting the arch. These recesses are entirely open in front, in all their height and breadth; they are scarcely more than very small closets, seldom exceeding six feet in breadth, rarely so deep as wide, but generally from eight to ten feet in height, and occasionally more. But in the more respectable parts of large bazaars there is generally a little door in the back wall which conducts to another small and dark closet, which serves the purpose of a store-room. The front cell is the shop, on the floor of which the master sits with his goods all around him, the articles most in demand being placed so within his reach that he has seldom occasion to rise, which, if he is a Turk, he rarely does without manifest reluctance. Such a dealer offers a very singular contrast to our ideas of a shopkeeper, being the very personification of luxurious repose as he sits smoking his pipe; or, if in winter, when these berths are chilly and uncomfortable, bending over a brazier of burning charcoal. The neighbouring shopkeepers have much communication with one another, and generally exhibit as much alacrity in promoting the interest of a neighbour as can be compatible with attention to their own. Indeed, a stranger might be disposed to imagine that all the tradesmen in the same line of business are in a general partnership, so little anxiety does any one exhibit to obtain a preference, and so willingly does he inform a customer where he may obtain an article more exactly suited to his wants than he can himself supply. This is more apparent in Turkey than in Persia. Persian, Armenian, and Jewish shopkeepers are in general more civil and obliging than Turks, and exhibit more anxiety to obtain custom. The writer has often been constrained by the former to turn aside and smoke of their pipes, and eat of their onions and bread, without being directly urged to make any purchase; but it is more pleasant to deal with a Turk, though he would not do this, because he deserves more confidence, yet not implicit confidence, in matters of purchase and sale. A French writer (M. Aubert de Vitry) says, "It is not necessary to offer a Turk less than two-thirds of the price he demands; to a shopkeeper of any other nation one-half may be safely offered; and in the case of the Jews there is no limit to the abatement." This is perfectly true; and no stranger in the East could have a better rule for his guidance in such matters.

Business commences and terminates with daylight in oriental bazaars. No trade or handicraft employment is in general carried on in the East by candle-light. None of the shopkeepers or artisans reside in the bazaars. When it gets dark, every one shuts up his shop and goes home. The fastenings of the shops are very slight; but the bazaars are in general well watched, and frequently secured with strong gates. In very warm countries it is usual for the majority of the shopkeepers to close their shops at mid-day, and go home to have their lunch and enjoy a siesta. The bazaars have then a very deserted appearance. Larcenies in the bazaars are scarcely known in Turkey; hence the shopkeepers do not hesitate to leave their shops quite open, without any one in charge, during their occasional absences; but when a rather long absence is intended, and the goods are of great value, a net, like a cabbage-net, is sometimes hung up in front, or laid over the goods.

The peculiar principle of oriental bazaars is, that all the shops of a city are there collected, instead of being dispersed in different streets as in Europe, and that in this collected form the different trades and occupations are severally associated in different parts of the bazaar, instead of being indiscriminately mingled as in our streets. Thus, one passage of the bazaar will be exclusively occupied by drapers, another by tailors, another by cap-makers, another by saddlers, and so on. In the bazaars of Persia, and, although less usually, in those of Turkey, the shops of provisions for immediate use form an exception to the rule. The shops of cooks and bakers are dispersed in different parts of the bazaar; the preparations in the former seldom extend beyond soups, and a sort of sausage without skin, called *kaboob*, a highly-seasoned and savoury article, which is much relished both in Turkey and Persia. Not only are trades carried on, but handicraft employments are exercised in the bazaars of the East; and thus while one part is very quiet, another resounds with the hammers of carpenters, smiths, and shoemakers. The stocks of the individual dealers are seldom of much

value; but an imposing effect is produced by the exhibition of the several stocks in a connected form, so that the whole of a particular street in a bazaar will appear as one great shop for the article in which it deals. This is the cause of the reported splendour and riches of an oriental bazaar. Of this kind of effect the bazaar for ladies' slippers in Constantinople is a very remarkable instance; such an extensive display on each side, through a long covered street, of small slippers, resplendent with gold and silver embroidery, and silk, and coloured stones, conveys an impression of wealth, luxury, and populousness which ten times the number of shops in a dispersed form would not give. Wholesale dealers have no open shops in the bazaars, but they have warehouses in it or in its vicinity, to which the retailers resort as they have occasion. These warehouses are frequently in a large house or khan, occupied in common by several wholesale dealers. The khans also, to which the itinerant merchants resort until they have disposed of their goods, are generally in or near the bazaars; and they frequently make use of the same building with the stationary merchants.

Besides the regular business conducted in the bazaars by the pro-



[Turkish Bazaar, from the French work on Egypt.]

fessional shopkeepers, there is an under-current of irregular trade, highly characteristic of oriental manners. If a person not in business, or a stranger, has an article of which he wishes to dispose, he employs a crier, who takes it through the bazaar, proclaiming at the top of his voice its praises and its price. Many poor people also endeavour in the same manner, without the services of the crier, to dispose of such articles of their property, or produce of their industry, as they desire to sell. These are mostly persons who imagine they shall be able to obtain a better price from the purchasers or idlers in the bazaar than they have found the shopkeepers willing to give. There is also a class of sellers who exhibit a little stock of wares upon stools, in baskets, or on cloths spread on the ground. They generally deal in but one commodity, which they profess to sell on lower terms than the shopkeepers will take. It would seem that in respectable towns a preference is given to this mode of selling some one particular commodity. Much tobacco, and most of the little snuff that is used, are sold in this way at Bagdad; much opium is thus disposed of every morning at Tabreez in Persia; and at Constantinople many women post themselves in the bazaars, displaying embroidered handkerchiefs and other needlework, often wrought by the hands of ladies of quality, who are enabled by the produce to make a private purse for themselves, and purchase some little indulgences which they might not otherwise obtain.

In hot weather, oriental bazaars are traversed by men laden with a skin or pitcher, from which they deal out to the thirsty a draught of excellently filtered water. Sometimes payment, seldom exceeding the fourth of a farthing, is expected; but frequently the men are employed to distribute water gratuitously, by pious individuals, who consider it an act of charity acceptable to Allah.

The contrast between the deserted appearance of the streets in an oriental town and the thronged state of the bazaars surprises a stranger. The women, except those of the lowest class, go little abroad; and of the men, the idle resort to the bazaar for amusement or conversation; and those who are not idle generally have some business there in the course of the day, which collects the visible population much into that part of the town, until the approach of evening effects a more equal distribution. The bazaar is not only the seat of immediate traffic, but of all commercial business; there all public, mercantile, and private news circulates, and there only free discussion can be carried on, unrestrained by the presence of the emissaries of power who haunt the coffee-houses. Public measures are keenly investigated, and the popular voice is often loudly expressed even to the ears of princes or ministers if they appear in the bazaars, as they sometimes do. Through the medium of slaves, eunuchs, and other agents, a constant intercourse is maintained between the innermost recesses of the seraglio and the bazaar. This is particularly the case at Constantinople, and in the capitals of the Turkish pashalics, and it is doubtful whether any thing

is transacted in the palaces at night, which is not known in the bazaars the next morning. This intercourse has often exercised an influence upon public affairs which none but the most minute inquirers into oriental history would suspect.

The various characteristic displays of oriental manners which the bazaars furnish, the nature of the goods exposed for sale, and the splendid appearance they sometimes make, the manner in which the artisans conduct their various labours, the endless variety of picturesque costumes which meet the eye, and the Babel-like confusion of tongues, all combine to form a scene of unequalled singularity and interest. No traveller who does not, in some oriental costume, sedulously frequent the bazaars and make many little purchases for himself, ought to feel assured that he understands the people, or has materials for fairly estimating their condition. The remarks here made are the result of the writer's intimate personal acquaintance with the bazaars of the East.

In this country the term bazaar is chiefly applied to large buildings, in which are arranged counters for the display and sale of articles of ornament, millinery, jewellery, toys, &c. They chiefly differ from arcades in not having distinct shops. [ARCADE.] These bazaars are of very recent date; the Soho Bazaar, the oldest establishment of the kind in the metropolis, having been founded in 1815. But the modern bazaar scarcely differs from the old Royal Exchange, and Exeter 'Change in the Strand, so often spoken of in the lighter literature of the latter part of the 17th, and early part of the 18th centuries. Besides the Soho Bazaar, there are in London the Pantheon, in Oxford Street; the Portland Bazaar, Langham Place; the London Crystal Palace, Portland Street, Oxford Street; the Pantechnicon, Pimlico; and the Baker Street Bazaar, near Portman Square. The two last, however, differ from the other bazaars in being places for the sale of carriages, furniture, pianofortes, and other heavy goods. Bazaars for the sale of light fancy goods, toys, &c., of a similar description to the London bazaars, have also been established in many of the larger towns and watering-places in various parts of the country.

On the continent, the bazaar is sometimes a market-place; sometimes, as at Antwerp, an Exchange combined with a place for the display and sale of articles of luxury, or a bazaar in our ordinary acceptation of the term.

BDELLIUM. Two resinous substances have both received this name. One is the *Indian Bdellium*, or *false myrrh*, and is obtained from the *Amyris Commiphora*. It is the bdellium of Scripture. The other is termed *African Bdellium*, and is produced from the plant *Hendolotia Africana*, a native of Senegal. The Indian bdellium is very similar to myrrh, and the tree which produces it diffuses a grateful fragrance to some distance around it. The African bdellium is much less odoriferous; it occurs in rounded or oval masses, from one to two inches in diameter, and has a dull wax-like fracture. According to Pelletier, it consists of

Resin	59·0
Soluble gum	9·2
Bassorin	30·6
Essential oil and loss	1·2
	100·0

Johnston gives the formula $C_{40}H_{31}O_5$ for bdellium (African ?).

BDE'LLIUM, *Medical uses of*. Resembling myrrh in appearance, it also resembles it in its effects upon the human system, and is often fraudulently substituted for it; it is, however, weaker, while it is more disagreeable and acrid. [BALSAMODENDRON.] It was formerly used in many compounds and plasters, such as *diachylon*. It is now disused in Britain; but is to be found intermixed with gum Arabic.

The bdellium mentioned in the second chapter of Genesis has been supposed to mean *pearls*.

BEACON, a sign or token ordinarily raised upon some foreland or high ground as a sea mark. It is also used for the fire-signal which was formerly set up to alarm the interior of the country upon the approach of a foreign enemy. The word, as used in England, is derived from the Anglo-Saxon beacen or beacn, a sign or signal, whence bycnian, to show or point out. *Beac* or *bec* is the real root, which we still have in *beck, beckon*.

Fires by night, as signals, to convey the notice of impending danger to distant places with the greatest expedition, have been used in almost all countries. They are mentioned in the prophecies of Jeremiah, who (chap. vi. v. i.) says, "Set up a sign of fire in Beth-haccerem, for evil appeareth out of the north, and great destruction." Æschylus, in his play of the 'Agamemnon,' represents the intelligence of the capture of Troy as conveyed to the Peloponnesus by fire-beacons.

Lord Coke, in his 'Fourth Institute,' chap. xxv., speaking of our own beacons, says, "Before the reign of Edward III. they were but stacks of wood set up on high places, which were fired when the coming of enemies was descried; but in his reign pitch-boxes, as now they be, were, instead of those stacks, set up; and this properly is a beacon." These beacons had watches regularly kept at them, and horsemen called hobbelars were stationed by most of them to give notice in daytime of an enemy's approach, when the fire would not be seen. (Camd. 'Brit.' in 'Hampshire,' edit. 1789, vol. i. p. 173.)

The Cottonian manuscript in the British Museum, Augustus I., vol. i. art. 31, preserves a plan of the harbours of Poole, Purbeck, &c., followed (art. 33) by a chart of the coast of Dorsetshire from Lyme to

Weymouth, both exhibiting the beacons which were erected on the Dorsetshire coast against the Spanish invasion in 1588. Art. 58 preserves a similar chart of the coast of Suffolk from Orwell Haven to Gorlston, near Yarmouth, with the several forts and beacons erected on that coast.

The power of erecting beacons was originally in the king, and was usually delegated to the lord high admiral. In the eighth of Elizabeth an Act passed touching sea marks and mariners (chap. 13), by which the corporation of the Trinity House of Deptford Strond were empowered to erect beacons and sea-marks on the shores, forelands, &c., of the country according to their discretion, and to continue and renew the same at the cost of the corporation.

Professor Ward, in his 'Observations on the Antiquity and Use of Beacons in England' ('Archæologia,' vol. i. p. 4), says, the money due or payable for the maintenance of beacons was called *Beconagium*, and was levied by the sheriff of the county upon each hundred, as appears by an ordinance in manuscript for the county of Norfolk, issued to Robert de Monte and Thomas de Bardolfe, who sat in Parliament as barons, 14th Edward II.

The manner of watching the beacons, particularly upon the coast, in the time of Queen Elizabeth, may be gathered from the instructions of two contemporary manuscripts printed in the 'Archæologia,' vol. viii. pp. 100, 183. The surprise of those by the sea-side was usually a matter of policy with an invading enemy, to prevent the alarm of an arrival from being spread.

An iron beacon or fire-pot may still be seen standing upon the tower of Hadley Church in Middlesex. Gough, in his edition of Camden, fol. 1789, vol. iii. p. 281, says, "at Ingleborough, in Yorkshire, on the west edge, are remains of a beacon, ascended to by a flight of steps, and ruins of a watch-house." Collinson, in his 'History of Somersetshire,' 4to, 1791, vol. ii. p. 5, describes the fire-hearths of four large beacons as remaining in his time upon a hill called Dunkery Beacon in that county. He also mentions the remains of a watch-house for a beacon at Dundry (vol. ii. p. 105). Beacon-hills occur in some part or other of most counties of England which have elevated ground. The Herefordshire beacon is well known. Gough, in his additions to Camden, ut supr. vol. i. p. 394, mentions a beacon hill at Harescombe in Gloucestershire, inclosed by a transverse vallation 50 feet deep. Salmon, in his 'History of Hertfordshire,' p. 349, says, at Therfield, on a hill west of the church, stood one of the four beacons of this county.

BEACON. [LIGHT-HOUSE.]

BEAD-MOULDING. [MOULDINGS.]

BEADLE, the messenger or apparitor of a court, who cites persons to appear to what is alleged against them. It is probably in this sense that we are to understand the *bedelli*, or under-bailiffs of manors mentioned in several parts of the 'Domesday Survey.' Spelman, Somner, and Watts, all agree in the derivation of beadle from the Saxon bydel, a cryer, and that from bid, to publish, as in bidding the banns of matrimony. The bedelli of manors probably acted as criers in the lord's court. The beadle of a forest, as Lord Coke informs us in his Fourth Institute, was an officer who not only warned the forest courts and executed process, but made all proclamations.

Bishop Kennett, in the Glossary to his 'Parochial Antiquities of Oxfordshire,' says that rural deans had formerly their beadles to cite the clergy and church officers to visitations and execute the orders of the court Christian. Parochial and church beadles were probably in their origin persons of this description, though now employed in more menial services.

Bedel, or beadle, is also the name of an officer in the English universities, who in processions, &c., precedes the chancellor or vice-chancellor, bearing a mace. In Oxford there are two esquire and three yeomen bedels, each attached to the respective faculties of divinity, medicine and arts, and law. In Cambridge there are three esquire bedels and one yeoman bedel. The esquire bedels in the latter university, beside attending the vice-chancellor on public solemnities, attend also the professors and respondents, collect fines and penalties, and summon to the chancellor's court all members of the senate.

BEADS. The manufacture of glass beads is carried on in the following manner, at Murano near Venice. Tubes of glass of various colours are drawn out to great length, in a gallery adjoining the glass house; in the same way as barometer and thermometer tubes are drawn out in an English glass house. The tubes are then cut into very small pieces of nearly uniform length, on the edge of a fixed chisel. These small pieces are put in a heap into a mixture of fine sand and wood ashes, and stirred about with an iron spatula till their cavities get filled. The mixture is transferred to an iron pan suspended over a moderate fire and continually stirred until the cylindrical bits assume a smooth rounded form. When removed from the fire, and cleared out in the bore, they constitute beads.

Foreign beads are imported to the value of 8000*l*. to 10,000*l*. annually.

Beads are also made to an enormous extent in Birmingham; where certain varieties of them are sold in thousands of dozens for *dolls' eyes*.

Beads were used as ornaments, both as necklaces and armlets, from a very remote period. In 1839, on removing parts of a barrow at Northwold in Norfolk, there were found sixty-five beads of dark blue glass, rock crystal, and vitrified paste, cut in facets, and which most likely had formed the necklace of an Anglo-Saxon lady. About

1851, there was found a number of beads at Donaghadee, in the county of Down, Ireland; 150 glass beads were found, of various colours, with spiral ornaments in yellow enamel, with several others of amber. They were of various sizes, and probably also formed a necklace. From the bronze articles found with them there is little doubt that they are Roman, though, as the Romans had no settlement in Ireland, it is not easy to say how they came there. ('Archæological Journal' for 1856.)

BEADS (Rosary) are made of horn, ebony, ivory, glass, boxwood, and other materials, and are strung in chaplets used by the Roman Catholics for the purpose of counting their prayers. The Rosary is a series of prayers said to have been first instituted by St. Dominic about the year 1200, in honour of the Virgin Mary, and as an invocation to her for spiritual assistance. It consists of a repetition of the Ave Maria and the Paternoster or Lord's Prayer, both in Latin. It is divided into decads of ten Ave Marias, each decad being preceded by the Lord's Prayer, and terminating with the Gloria Patri. The full or great rosary consists of fifteen decads, but the common rosary, which is recited generally in the evening by pious Catholics, consists of only five decads. At the end of the five decads they recite the Creed, or Symbol of the apostles, and afterwards (in Italy at least) the Litany of the Virgin, which is different from the Litany of the Liturgy. The rosary is a daily family evening prayer; the head of the family says the first part of each Ave Maria, and the other members repeat in chorus the remaining part. [Ave Maria.] "The original rosary of St. Dominic is a recitation of fifteen decads of Ave Maries, preceded each by a Pater, each decad being devoted to the meditation of one of the mysteries of the life of our Saviour. The first five mysteries are those of the incarnation, nativity, &c., and are styled joyful mysteries. The next five are those of the passion and death, and are styled sorrowful. The remaining five are those of the resurrection, ascension, assumption of the Virgin, &c., and are termed glorious." (Touron, 'Vie de St. Dominic;' 'Quindecim Mysteria Rosarii Beatæ Mariæ Virginis,' a R. Schiaminosso delin. atque incisa, Rome, 1609.) The common chaplet is called *Corona*, "a crown," in honour of the Virgin.

The beads are distinguished by their size and shape, those marking the Lord's Prayer being larger than those for the Ave Marias. Rosaries of very small glass beads are worn by pious Catholics round their necks. The object of St. Dominic was probably, while doing honour to the Virgin, to fix at the same time the attention of the pious on the contemplation of the principal events of the Saviour's life, by allowing a certain time, marked by the recitation of ten Ave Marias, to the meditation upon each event or mystery. The name of rosary is figurative: it means a chaplet of spiritual roses, divided into three sets, white, red, and damask roses, corresponding to the joyful, sorrowful, and glorious mysteries. Such are the allegory and its explanation. ('The Rosarie of our Ladie otherwise called our Ladie's Psalter,' Antwerp, 1600.)

The Turks and other eastern nations have also chaplets of beads made of amber or other materials, which they turn through their fingers while sitting in a listless mood, but not, as it seems, for any purpose of prayer. The Turkish chaplet is called "Comboloïo." The Chinese rosary consists of 108 beads of stones and coral, sometimes as large as pigeons' eggs, and is a part of the ceremonial dress, worn as a necklace and descending to the waist with certain beads introduced to mark the rank of the wearer. A smaller rosary of eighteen beads is used by the bonzes and the laity.

BEAMS. [Materials, Strength of.]

BEAN, THE. Of this leguminous plant many varieties, classed however under only one species botanically, are extensively cultivated in the garden and in the field. It is the *Faba vulgaris* or *Vicia Faba*, which is our common garden and field bean. The French bean, haricot, or kidney-bean is an altogether different plant—*Phaseolus vulgaris*. We here consider them only from the agricultural point of view.

The common bean bears a pod containing several oblong rounded seeds, which are used in the soft young state for the table, and in the hard dry state for domestic animals chiefly, either whole or ground into meal. In some places bean-meal is mixed with other meal in making coarse bread; or the beans are boiled into a mess with fat meat, in which state they are very palatable and nutritious. The bean came originally from the east, and was cultivated in Egypt and Barbary in the earliest ages of which we have any records. It spread thence into Spain and Portugal, from whence some of the best varieties have been introduced into this country. The most common varieties of the garden beans are the Windsor, the Toker, the long-pod, and the Mazagan, all productive and well-tasted. In the field the tick bean, the common horse bean, the winter bean, and the small Dutch, or Heligoland bean, are preferred, being hardy as well as productive. The long-pod is occasionally sown in the field, the Mazagan and broad Windsor bean seldom.

There is no plant in which the transformation of the cotyledons into seed leaves is more readily traced than in the bean. The Windsor bean, in particular, from the size of its lobes and distinctness of its vessels, is admirably adapted for observation, the parts being readily distinguished by the naked eye. If a bean is planted in moist earth or soaked in water, in a moderate temperature, the cotyledons will swell and soon burst the skin which envelops them, separating into two lobes, which open like the shells of an oyster. In the part which forms

the joint an oblong body will appear, which is the embryo stem of the plant. This increases rapidly in the earth, and pushes a root downwards, and a stem upwards, which latter carries the lobes with it till they rise above the ground, when they expand, and are transformed into seed leaves. It is curious to observe the force of vegetation in the young bean when it is, as it were, imprisoned in a strong soil hardened at the surface, as may be seen when a path crosses a field of beans newly planted; the cotyledons, under these circumstances, are drawn into the crevices made by the young stem, where they often remain held fast till the first shower releases them. The change in the cotyledons deserves particular attention. As soon as the seed swells by imbibing moisture, the oxygen, which is always present in the atmosphere and in water, acts upon the farinaceous substance in the seed, and takes a portion of carbon from it producing carbonic acid, which is absorbed by the surrounding plants, or flies off in the state of gas: by this loss the remaining substance becomes a mild fluid emulsion, analogous to the milk of animals, which, being taken up by the minute vessels of the radicle, nourishes and increases them. It is this alone which produces the first growth; the earth is the mere cradle to protect the young plant and to keep it moist, by preventing the too rapid evaporation which the heat and light of the sun would otherwise produce: when the ground is entirely deprived of moisture, vegetation necessarily ceases. The cotyledons are the reservoirs of nature to supply proper food for the plant in its infant state. In proportion as the farina in the lobes is gradually exhausted new vessels appear through the substance of the lobes, conveying the newly formed juice from every part of them into the root and stem, and, at last, the cotyledons are transformed into seed leaves. The fibres of the roots are by this time completely formed, and have acquired the power of absorbing nourishment from the soil. [Root.] The plant may now be said to be weaned. The stem is then considerably advanced in growth, having put forth new leaves of a different form from the seed leaves: these last, having now performed their part, wither and soon fall off; if they are removed before this period, the plant, having lost its nurse, languishes and dies.

The bean at this stage of its growth requires particular attention. If the soil is rich and well prepared, it will grow rapidly and luxuriantly, and be soon out of reach of insects or weeds, and capable of resisting or of turning to account the varying influences of the atmosphere; but if the soil is poor and parched, and the supply of nutritive juices is scanty, the plant will soon show weakness and disease, and the only way to prevent a total failure of the crop, is to supply by art the deficiency of nature. In very poor soils manure may be applied in a liquid state, or as a top-dressing: in those which are not exhausted, tillage alone will enable the roots to spread, and give them a wider range to seek their food in. The weeds being destroyed, the whole powers of the soil are reserved for the crop; and the air charged with fertilising vapours being allowed to penetrate the surface, and being retained in the interstices of the soil, greatly assists in invigorating the vegetation. These are the principles on which is founded the whole culture of leguminous plants, whether in the garden or the field. Where labour is not spared and the produce is valuable, and where vegetables are raised as a kind of luxury for the tables of the rich, the greatest attention is paid to the cultivation of beans, so as to have them early and in regular succession during the whole summer. They are even occasionally raised by artificial heat. In general they are sown or planted at various times, from the beginning of winter to the middle of summer, but they must be protected from frost in the first case, and from too great heat and drought in the latter. They are set in rows with wide intervals, which are kept dug and clean, and in which lesser vegetables are advancing in growth, to be sheltered by the beans, and to succeed them when removed. In order to strengthen the pods already formed, as soon as those which are near the bottom of the stem are filled, the tops of the plants are cut off, and the beans are gathered when the seed has acquired sufficient consistency to be taken from the shells, before they have acquired any farinaceous qualities. One crop is made to succeed another by regulating the times of sowing; and thus beans are gathered for the table from May to November, or till the frosty nights check the growth of the plant. The cultivation of the field bean is only as perfect an imitation of the garden culture as circumstances will permit. As only one crop is required, and that in a perfectly ripe state, when the seeds are fully formed and hard, they are sown at one particular season, so as to avoid the danger from frosts and ungenial weather in spring, and at the same time to have the crop ripe in good time to be harvested before the cold and wet season sets in. The usual mode is to drill them by a machine, at the distance of from twenty to thirty inches, according to the richness of the soil, or to dibble them by hand, either singly or by putting two or three beans in each hole, increasing the distance of the holes from six to twelve inches. Beans are tolerably hardy, and will bear moderate dry frosts; but they suffer much from alternate frosts and thaws, which in this climate are so common in February. The end of February, or the beginning of March, is therefore generally preferred for bean-sowing. When the season is remarkably mild, as was the case in 1834, early sowing is a great advantage. The writer of this article planted a field of beans on the 1st of January, 1834, in a soil duly prepared; they were reaped in August, and produced a very good crop: his neighbours, who planted their beans in March, had not half the quantity on equally

good land, owing to the dryness of the summer. But this was an experiment which succeeded: had severe weather come on in February, the whole crop might have been lost. As a general rule, beans may be sown from the middle of February to the middle of March. The sorts usually cultivated in the fields are the winter bean, the tick bean, the horse bean, and the small Dutch or Heligoland bean. In some situations the Mazagan and the long-pod have produced good crops in the field; the first four are however best suited for general cultivation. There are several varieties of these, which differ but little in their appearance; experience is the best guide in choosing the seed which suits particular soils and situations. The small round regular-shaped beans are generally preferred, as obtaining the best prices in the markets, especially in large towns, where there is a great consumption of beans by hard-working horses.

The soil best adapted for beans is a rich strong loam, such as produces good wheat. In such a soil the produce is sometimes fifty or sixty bushels per acre, but an average crop, on moderate land, is about half that quantity. On very rich land beans have produced extraordinary crops, by being sown broad-cast and very thick, the stems being drawn up to a great height in favourable seasons. A small field of very rich land, in the county of Sussex, was sown in the year 1832 with four bushels of the small tick bean, which came up so thick, that the proprietor thought of thinning out the plants by hoeing; but he was advised to see what the produce would be, and when they were threshed out, there were 10 quarters and 1 bushel of beans. He had the ground accurately measured, and it was found to be 1 acre and 29 perches, which makes the crop above 68 bushels per acre. They completely smothered all weeds, and the subsequent crop of wheat produced 5 quarters to the acre; but this particular example of sowing beans broad-cast we do not hold up for general imitation. By cultivating the beans in rows, and by careful hoeing and manuring, alternate crops of wheat and beans may be raised for many years, without intermission, or any necessity for change or fallow: this has been long the practice in the richest part of Kent. In this case the beans must be drilled or set in rows, with intervals of from 24 to 30 inches between the rows; and the intervals must be repeatedly stirred or hoed with proper instruments, so as to prevent the growth of weeds and keep the soil in a perfectly clean and mellow state; the weeds which rise in the rows are removed by hand. Immediately after bean harvest, the land is scarified, or skimmed over with a plough having a very broad share, whence the operation is sometimes called *broad-sharing*. All roots of weeds and the remains of bean-halm are collected and burned, or put in a heap with quicklime, to be converted into manure. The ground is then ploughed once or several times, according to circumstances, and wheat is sown about the month of October, either broadcast or by means of a drilling-machine, in rows 10 or 12 inches asunder, which gives greater facility for hoeing and weeding the crop when necessary. The wheat which follows beans is generally good and heavy, and seldom runs to straw. After wheat-harvest the stubble is ploughed up and turned in with a very deep furrow; the land is harrowed flat, and a good coating of manure is put on in a moderately rotten state, and this is covered with a shallow ploughing: the land is well water-furrowed and left so till spring, when the beans are drilled in the mellow surface produced by the winter's frost. This is the most approved practice; but many experienced farmers vary it according to the varieties of soil, or according to difference of opinion. Some put on manure for the beans in spring, and some drill the beans in every second or third furrow after the plough; but all good farmers agree in manuring the land for the beans and carefully hoeing them. It is evident that a different method is required in different soils, varied according to their texture and situation. Alternate crops of wheat and beans can only succeed, for any length of time, on soils peculiarly favoured. In general, a change of crops and occasional fallows will be indispensable to keep the land perfectly clean and in good heart.

In cold wet soils beans require great care to ensure good crops. Although they will grow well and seem to flourish in the stiffest and most unsubdued clays, they will seldom produce much at harvest, unless the land has been well prepared and the cultivation managed with skill. There is no better criterion of the experience and industry of the farmer of cold wet clays than the appearance of his beans at harvest; and he may be judged by this crop, as the farmer of light sandy soils may be judged by his turnips. The cultivation of these two opposite kinds of inferior soils will, in general, be profitable or otherwise in proportion to the produce of the beans in the one and the turnips in the other; the first being a substitute for clean fallow, and the latter the foundation of all the succeeding crops. The bean, by its strong and penetrating root, opens the stiff soil to the influence of the atmosphere, by which the surface is dried and at the same time mellowed. Although the nutritious matter in a good crop of beans is great, and almost equal to that obtained from a crop of wheat, it exhausts the soil much less: its succulent stems and leaves absorb much nourishment from the atmosphere, and the latter falling off and decaying, restore carbon and mucilage to the soil, and make up for the inferior quantity of manure produced by the bean-halm in comparison with wheat-straw. There is perhaps no crop, bearing seed, which gives so great a return with so small an expenditure of the fertility of the soil; and certainly none that repays manure better, or leaves the land in a better condition for wheat or oats. It is a very common practice

to plough a stiff soil in spring only once, after it has borne clover, grasses, or wheat, and to drill beans in the furrows immediately after the plough, by hand or by an instrument; in this case it is best to deposit the beans as near the angle of the furrow as possible, and in every second furrow only, that they may rise regularly at a proper distance. In spite of the tough slices which the plough turns over in a mass, the force of vegetation in the bean makes it pierce through them, and, under favourable circumstances, a tolerable crop is sometimes obtained; while the more industrious neighbour, who has tilled his land in autumn and again in spring, by repeated ploughings, and made it fine and mellow, may be disappointed in his crop by untoward variations of weather. The slovenly farmer then laughs at the more perfect system of the other, pretending that it is wrong to work strong soils so much and make them *too fine*, as the term is. Thus the progress of a whole district in rational and improved culture is arrested or checked by the apparent evil of frequent ploughing. But the conclusion is founded in error. There can be no rule better confirmed by experience than that adhesive soils should be stirred and divided as much as possible; but this must be done with due regard to circumstances and seasons, and the differences in soils: chalking, marling, or manuring are necessary, in order to prevent the divided soil from *setting* into a hard, compact mass. Light-coloured clays which consist of siliceous sand and argillaceous earth only, without any intermixture of other substances, set the harder in drying the more they are stirred; after being ploughed they soon have the appearance of stripes of unburned brick; and if a heavy shower has fallen after the land has been harrowed, they become hard like a barn floor. It is of no use to pulverise such land, until its texture is altered by chalk, marl, dung, or ashes; and the safest way is not to stir it too much, as no good crop can be expected at all events till it be ameliorated. To prepare a middling stiff soil for beans, it should be ploughed into high and narrow lands in autumn, with numerous and deep water-furrows, so that no water may lie on any part of it, and, if possible, it should be manured with long dung before it is ploughed. In spring, if there has been some frost, the surface will be loose and mellow; in this the beans should be drilled or dibbled by hand, and a time should be chosen for hoeing them, when the ground is neither wet nor dry, so that the hoe, whether hand-hoe or horse-hoe, may penetrate two or three inches below the surface to open the soil and destroy the weeds. The hoeing of the beans is a most essential part of the culture, and according as it is well or ill executed the land will produce more or fewer crops after it without its being necessary to have recourse to a fallow. Objections have been made to the use of the horse-hoe and scarifier between the rows in stiff soils; because, when the ground is dry and caked, the hoe raises large clods and lays the roots bare, sometimes even destroying the plants. But there are means of preventing this: if the ground is repeatedly hoed when not quite dry, it will not bind into a hard crust or rise in clods; and should a sudden dry wind, after much rain, bake the surface in spite of every attention to it, a rough roller, of such dimensions as to work between the rows, will effectually loosen the soil, so that hoes and grubbers may follow without inconvenience.

When the beans have pushed their stems, and the proper leaves appear above the seed-leaves, the intervals should be carefully hoed, and, where it is practicable, three or four bushels of gypsum per acre may be sown, if the soil does not already contain this substance, and it will greatly stimulate the growth. The mode of its operation is not exactly known, but experience has proved its utility. [MANURE; GYPSUM.] A small quantity of gypsum seems to stimulate the growth of all leguminous plants and clovers; but if this quantity be already present in the soil, no additional quantity seems to have any effect. It has been recommended to cut off the tops of the plants when the lower pods are set, as is frequently done in garden culture, to accelerate the filling of them, and to prevent useless blossoms from drawing the nourishment to the top. The reason for doing this in gardens is, that when a plant has borne pods a certain time it is most advantageous to remove it, and the top blossoms, of course, never come to perfection. In the field this is not the case, there being no succession of plants; and, unless the top blossoms are very late, or the black dolphin (*aphis*) begins to appear, which is shown by the honey-dew on the top shoots, no advantage is gained by topping the plants, and the labour is thrown away. When the leaves of the beans begin to lose their green colour, and the pods to turn black, the crop should be reaped with the sickle and made into small sheaves, tied with straw bands or tar twine, and set up in the field to dry. In some places peas are sown mixed with the beans, or the headlands are sown with peas, the halm of which is used to tie the beans with; but peas cling round the bean-stalks and impede the setting of the pods; they also interfere with the hoeing and weeding, so that the practice is not to be recommended. Peas require a lighter soil, and are best sown separately, except when they are sown broad-cast mixed with beans, in order to be mown in a green state as fodder for cattle or for pigs. Sowing beans for this last-mentioned purpose is not much practised in England, but is found very useful on the Continent, especially in Flanders; in this case they are mown like tares soon after the pods are formed. In order to have a succession of this green food, they should be sown at different times, with a week or fortnight's interval. By this means a great deal of grass is saved, which may be reserved for hay; the cattle

fed in the stables or yards thrive well on this food, and produce a quantity of rich manure, chiefly in a liquid state, which fills the tanks and reservoirs which we have repeatedly mentioned as indispensable appendages to every good farm-yard. By having winter tares when the turnips are consumed, peas and beans after the first crop of clover, and summer tares to succeed them, cattle may be fed in the stables all the year round with great advantage, the land may be tilled at the best season of the year, and prepared for wheat, as well as by a clean fallow, while the green crop will fully repay all the expenses. Three bushels of beans and two of peas, mixed together, are required per acre when sown broad-cast, or drilled in each furrow after the plough. It is often advantageous to cut in a green state those beans which were sown for a general crop when food for pigs is scarce; they will go nearly as far in this way in feeding store pigs as the beans would have done when ripe, and the ground is left in a better state for the following crop.

Beans may be either sown by drill, in rows one foot to two feet apart, or hand-dibbled, or sown by hand or by barrow in the wake of the plough, under every second or third furrow-slice; or sown on manure in drills between ridgelets, 28 to 30 inches apart, being then covered by the splitting of these ridgelets, and the land being then partly harrowed down and rolled. The wider intervals are best when the bean is considered as a fallow crop. If the land be clean, an interval of 18 inches is sufficient to allow air and light for the proper setting of the blossoms and growth of the pods. When winter beans are sown, the stubble (wheat or oats) should be broad-shared and cleaned and ploughed. Manure may (20 cubic yards per acre) then be carted on the land, and spread and ploughed in; and the land, being harrowed, is ready for the drilling-machine. The seed, two or two and a half bushels per acre, may be sown in October, in rows about 20 or 24 inches apart, and the land, being harrowed down and water-furrowed, is left for the winter. The spring cultivation, horse-hoeing and hand-hoeing, is the same only earlier, as for any other sort. The crop is generally ripe a month before the spring-sown sorts, and therefore both less liable to blight, and better enabling a partial fallow before the seed-time of the wheat crop, which succeeds it. The winter bean is better for the lighter class of soils than other sorts. It is a heavy bean per bushel, and a good cropper.

Although beans grow best in a rather heavy soil, they are often profitable on much lighter land, especially after clover lea or grass, which is broken up after being depastured two or three years. This is an excellent preparatory crop for wheat, and better than oats, which leave such land full of weeds. In this case the land should be carefully ploughed up. For this purpose a skim-coulter, which has a small wing attached to it, to slice off the grassy surface of the land and turn it under the furrow, is a most useful appendage to the plough. This makes very clean work, and a heavy roller drawn across the ridges or lands leaves the whole surface compact and solid, keeping the moisture from evaporating and facilitating the slow decomposition of the roots of the grass. Thus a very good and clean crop of beans may be obtained. If the soil should be exhausted or very poor, a good coat of manure spread over the grass and ploughed in will be a great advantage to the beans and to the wheat which is to follow. On moderately light loams a profitable rotation of crops is that of turnips, barley, clover, beans, wheat; or, if it is in a rich state, turnips, barley, clover, oats, beans, wheat, beans. When land is in good heart, beans are often added to any rotation after wheat or before it, and the fallow is thus removed a year farther on. This is likewise done when it is intended to change the course of crops; because beans are considered the least exhausting of the crops which are allowed to ripen their seeds, and this practice is far less hurtful than the too common one of taking another crop of oats after the wheat, by which more harm is often done than the value of the crop can compensate for.

The diseases to which beans are subject are, the mildew, which is a minute fungus that grows on the stems and leaves, and is caused by cold fogs and frequent sudden variations of weather, and the black dolphin, an insect of the *aphis* tribe, which appears first in the form of a honey-dew on the tops of the plants. For the mildew, no remedy or preventive has yet been found: whenever it has attacked the plants generally, before the pods are filled, the best method is to cut down the crop in its green state, and if it cannot be consumed in the farm-yard, to plough it into the ground, where it will decay rapidly, and be an excellent manuring for the succeeding crop of wheat. If allowed to stand, the crop will not only be unproductive, but the weeds will infest the ground, and spoil the wheat crop by their seeds and roots, which will remain in the soil. Whenever the tops of the beans begin to be moist and clammy to the feel, it is the forerunner of the *aphis*. They should then be immediately cut off, and this, if done in time, may save the crop from the ravages of the insects; but the most effectual way to prevent any disease from attacking the plants in their growth is to have the ground in good heart, and well tilled; to drill the beans at a sufficient distance between the rows to allow of the use of the horse-hoe, and thus to accelerate the growth of the plants, and enable them to outgrow the effect of incipient disease, which seldom attacks any but weak plants.

The principal use of beans is to feed horses, for which purpose they are admirably adapted, and far more nourishing than oats. They should be bruised or split in a mill, and given to horses mixed with hay and straw cut into chaff; this will ensure proper mastication, and

prevent that thickening of the wind, as it is called, caused by indigestion, which makes beans alone not so well adapted for the food of hunters and race-horses. Great quantities of beans are consumed in fatting hogs, to which they are given whole at first, and afterwards ground into meal. Bacon hogs may be fatted entirely on beans and bean-meal; but as this food makes the flesh very firm, it is not so well adapted for delicate porkers. In the last period of their fatting, therefore, barley-meal is usually substituted for bean-meal. Bean-meal given to oxen soon makes them fat, and the meat is far better than when oil-cake is used for that purpose: mixed with water and given as a drink to cows, it greatly increases their milk. A small quantity of beans is generally mixed with new wheat when ground to flour; the millers pretend that soft wheat will not grind well without beans, and they generally contrive that there shall be no deficiency in the necessary proportion. Thus a quantity of beans is converted into what is considered as wheaten flour. This practice is well known to all bakers and dealers in flour; and as there are means of discovering the quantity of bean-meal in the flour, the ignorant and unsuspecting only are deceived, and the price of the flour to the skilful purchaser varies according to the quality. The bean contains a great deal of nutritious matter—23 per cent. of nitrogenous or flesh-forming substance and 48 per cent. of starch, with 10 per cent. of woody fibre, 3½ per cent. of ash, and 14 or 15 per cent. of water, in its ordinary condition in the market. The ash of the grain and of the straw respectively contains, according to Way and Ogston ('Journal of the English Agricultural Society'), as follows:—

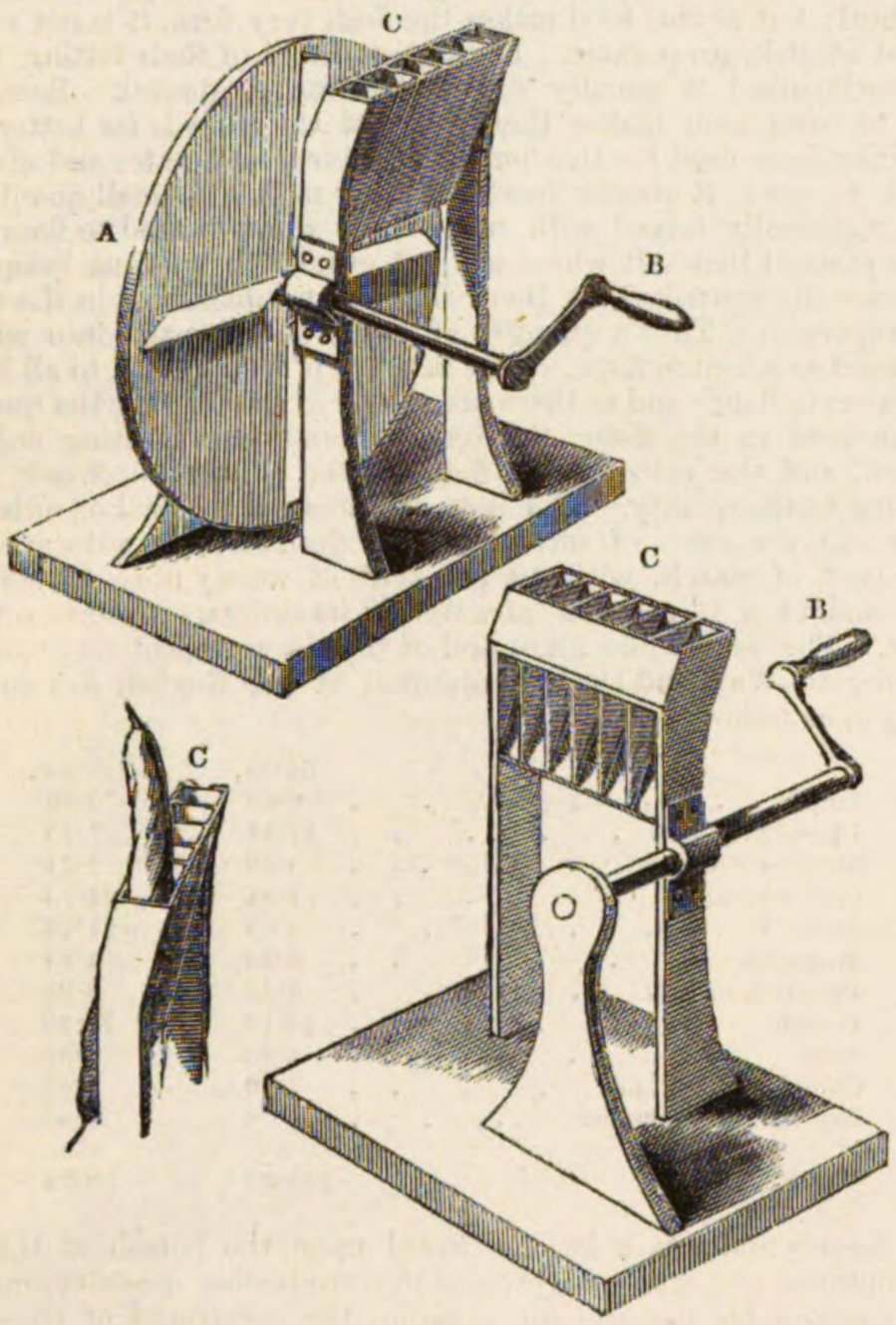
	Beans.	Straw.
Silica	0·88	3·86
Phosphoric acid	31·87	7·35
Sulphuric acid	4·50	3·21
Carbonic acid	1·94	22·73
Lime	8·65	21·29
Magnesia	6·55	4·88
Peroxide of iron	0·36	0·90
Potash	42·13	21·26
Soda	0·90	4·56
Chloride of Sodium	1·90	9·05
Chloride of Potassium	0·34	0·90
	100·02	99·99

These figures indicate a large demand upon the potash of the soil. The sulphuric acid and lime, present in considerable quantity, indicate also a considerable demand for gypsum, the compound of these two substances, which has in fact been found a good manure for the bean crop.

The French bean, kidney-bean, or haricot bean (*Phaseolus vulgaris*), is chiefly cultivated for its tender and succulent pod, being one of the most esteemed vegetables for the table. The varieties are innumerable, differing slightly in their qualities: they may be divided into two distinct kinds, the dwarf and the climbing; the former are the earlier, the latter the more productive. French beans are much less hardy than the common beans; a very slight degree of frost will destroy them entirely. The early sorts are therefore sown in sheltered situations, and occasionally protected by glass frames or mats. The climbing beans require the support of sticks or wires, round which they twine as they grow, with this peculiarity, that the coils turn round the support from the right to the left, contrary to the growth of some indigenous twisting plants, which turn from the left to the right, following the apparent diurnal motion of the sun.

The French bean, as an esculent vegetable, is wholesome and nutritious in a fresh state, and may be readily preserved for winter store or sea voyages by salting in casks. For this purpose the large, flat-podded, Dutch white runner is preferred. In Holland and Germany, where large quantities are salted in almost every family, a machine is used for cutting them expeditiously, which greatly resembles a turnip-slicer, and may, with a slight alteration, be used also for slicing cabbages when making the national German preparation of sour-krout (*sauer-kraut*). It consists of a wheel or disc, A, in which two or four knives are set at a small angle with the plane of it, so as to shave off a thin slice obliquely from the beans, which are held in a box, C, with several partitions in which they are kept upright, so as to slide down in proportion as they are cut: thus six or eight beans are sliced at once, and very rapidly, merely by turning the handle B, and supplying the box with beans in succession. The sliced beans fall on the table below, and are immediately put in a cask with alternate layers of salt. When the cask is full and well pressed down, a round board is put over the beans and a heavy weight upon it. As the beans are compressed, and begin slightly to ferment, the liquor is poured off, some fresh salt is strewed over the surface, and a linen cloth is pressed close upon it to keep out the air; the round board and weight are put over the cloth, and so the beans remain till wanted for use. When any are taken out, they are washed in soft water to take out the salt, and gently stewed with a little gravy, or with milk and a piece of butter. They form a very wholesome vegetable dish at a time when fresh vegetables are scarce. The dried seeds are also boiled after being soaked in water for some time, and are usually mixed with the preserved green beans in the same dish. This use of the French bean is not common in England; but when we take into consideration that they are extremely

wholesome and nutritive, much more so than peas, and that they are an admirable corrective of the oily qualities of animal fat by their farinaceous qualities, we shall regret that both the culture and the use of them in the dry state are not extended for the benefit of the labouring part of the community. The cultivation of the French bean



[Bean Cutter.]

for the seed is confined in this country to the gardens and nurseries, and to a few spots in the Isle of Thanet in Kent, where they are raised for the London seedsmen. This is the only place, as far as our observation goes, where they are sown in the field. The produce in seed is said not to exceed twenty bushels per acre, but it must be observed that it is chiefly the dwarf sorts which are sown. There is no doubt that the produce of the runners would greatly exceed this quantity, and although it might be expensive to support them with sticks, the example of the hop grounds proves that, where the return is large, no expense or trouble is spared.

The best soil for French beans is a rich mellow loam, rather light than otherwise; but, provided the ground be well stirred, they will grow in any soil. They may be planted in rows, the dwarf sorts at two and a half or three feet distance; the runners, at four feet. As soon as the stems begin to rise above the seed leaves, the intervals should be well hoed with the horse-hoe, and the rows by hand. The scarifier or grubber may be used to loosen the soil, and when they are somewhat advanced in growth the runners may have sticks to climb upon. A row of turnips may be sown between every two rows of beans, or cabbages may be planted for cattle. The crop may be harvested as soon as the lower pods are quite dry and the seeds hard, and threshed like other beans. The seeds when raw have a bitter taste, and are rather tough under the teeth, which makes animals refuse to eat them in that state; but when boiled, they become soft and pleasant. Oxen and pigs eat them readily. They contain, according to Einhof, 84 per cent. of nutritive matter, of which 50 is pure farina, the rest gluten and mucilage: they are consequently superior to every other grain or pulse cultivated, in point of nourishment; and when it is taken into account that they remain in the ground only from May to September, and that a crop of cabbages or turnips is growing in the intervals at the same time, it will appear that the cultivation of this pulse on a large scale might add greatly to the resources of agriculture.

In the three years ending with 1858, the importation of foreign beans amounted on an average to 357,000 quarters annually.

BEAR, GREAT AND LITTLE. [URSA MAJOR AND MINOR.]

BEAR'S WHORTLE-BERRY, the generic and specific characters of which are given under the article ARCTOSTAPHYLOS UVA URSI [NAT. HIST.], was used in medicine by the ancients, fell into neglect, and was restored about the middle of the last century. It possesses manifest astringent and, under certain circumstances, diuretic properties. The leaves are the part of the plant which is used. These are destitute of

smell, but have an astringent, bitter taste. Analysed by Meissner, 100 parts contained

Gallic acid	1·20
Tannin, combined with gallic acid	36·40
Resin	4·40
Chlorophylle	6·35
Extractive, with malates and other salts	3·31
Ditto, with citrate of lime	0·86
Gum and extractive	33·30
Lignin	9·60
Water	6·00
	101·42

The leaves are frequently intermixed with those of the *Vaccinium vitis Idœa*, or cow-berry, from which they may be distinguished by not being spotted nor having the margin revolute. The watery infusion of the cow-berry leaves, treated with muriate of iron, merely becomes green. The watery infusion of the bear-berry so treated throws down a blackish-gray precipitate; also with the leaves of the *Vaccinium uliginosum*, or bog whortle-berry. To distinguish them from these last is more important than from the foregoing, as the leaves of the bog whortle-berry are poisonous. They do not possess the leathery texture, or the reticulated character of the leaves of the *Uva ursi*. The leaves of the *Buxus sempervirens*, or common box, are often fraudulently intermixed with it. They may be distinguished by the veins of the leaves running from the mid-rib to the margin, not being reticulated like the *Uva ursi*, having an unpleasant smell, and yielding on analysis the principle called *buxin*.

The power of the leaves is greatest over the mucous membranes and the kidneys. The leaves rubbed with cold water yield up all their tannin and gallic acid, and thus afford an infusion of great efficacy in hæmorrhages from the prostate gland. In cases of tendency to calculous diseases, especially of the phosphatic diathesis, it is of great use when persevered in; also in catarrh of the bladder. It has been thought useful in consumption, and indeed its tonic power may render it occasionally serviceable. It is administered in powder, in the form of an infusion or decoction; but the best form in which it can be longest used is that of extract, as recommended by Dr. Prout.

(See Prout, *On Diseases of the Urinary Organs*, second edit., p. 185.)

BEARD, the hair which grows upon the chin and contiguous parts of the face in men, and sometimes, though rarely, in women. With men its growth is the distinctive sign of manhood. In its anatomical character it is shorter and thicker than the hair of the head; but longer, if suffered to grow, than that of other parts of the body. It generally, but not invariably, is of the same colour as the hair of the head, but always the same as that of the eyebrows. It is most prolific among men of what are called the Caucasian race; many of the peoples of Africa, America, and Australia have little or no beards. Some animals are provided with beards, or, as they are called, whiskers, which are held to be organs of touch.

The fashion of the beard has varied greatly in different times and different countries; and some of the learned in curious trifles have spared no pains to record the changes. Hotoman wrote a treatise expressly on the beard, entitled 'Pogónias' (ΠΩΓΩΝΙΑΣ), first printed at Leyden in 1586, and which, on account of its rarity, was reprinted at length by Pitiscus in his 'Lexicon.'

The earliest notice of attention to its growth is probably in Leviticus, where the lawgiver of the Jews (chap. xix. 27) says, "thou shalt not mar the corners of thy beard."

Generally speaking, the growth of the beard was cultivated among the nations of the East, although it must be observed that most of the Egyptian figures in the ancient paintings are without beards. In Rosellini's work we have a series of portraits of Egyptian kings, nearly all without beards. (See Plate No. x. &c.) From some of the statues, however, a curious beard-case appears to have been worn. The Memnon's head in the British Museum has this appendage, though no hair is shown on any part of the face. Another small bust, of which we give a representation, illustrates its appearance. The ancient Indian philosophers called Gymnosophists were solicitous to have long beards, which were considered symbolical of wisdom. The Assyrians and Persians also prided themselves on the length of their beards; and St. Chrysostom informs us ('Opera,' edit. Montfauc. tom. xi. p. 378) that the kings of Persia had their beards interwoven or matted with gold thread. The figures on the Assyrian slabs, brought to England by Mr. Layard, are usually represented with beards; and generally the beards on the reliefs from Persepolis in the British Museum, are most elaborately executed in a series of minute curls. Something of the same style of beard is still preserved in Persia, where it is dressed and trimmed with extreme care.

Aaron Hill, in his 'Account of the Ottoman Empire,' folio, London, 1709, p. 45, draws this distinction between the Persians and the Turks:

"The Persians never shave the hair upon the upper lip, but cut and trim the beard upon their chin, according to the various forms their several fancies lead them to make choice of; whereas the Turks preserve with care a very long and spreading beard, esteeming the deficiency of that respected ornament a shameful mark of servile slavery." The slaves in the seraglio are shaved as a mark of servitude.

Athenæus (xiii. p. 565, edit. Casaub. Lugd. 1657) observes from Chrysippus's treatise 'De honesto et voluptate,' that the Greeks wore their beards till the time of Alexander. The first person who cut his beard at Athens, he adds, was ever after called *κόρσην, the shaven.* Plutarch, in his 'Life of Theseus,' mentions incidentally that Alexander cut off the beards of the Macedonian soldiers, that they might not be used as handles by their enemies in battle. The Greeks continued to shave the beard till the time of Justinian, under whom long beards came again into fashion, and so continued till the taking of Constantinople by the Turks, in 1453. The Greek philosophers usually made the beard a distinguishing feature in their appearance, whence the proverb *ἐκ πωγωνος σοφοί.* Persius ('Sat.' iv. 1) terms Socrates *magister barbatus,* the "bearded master;" and Prudentius ('Apoth.' ii. 200) bestows the same title of *barbatus* upon Plato.

Varro ('De Re Rustica,' lib. ii. c. 11, edit. Commelin. 8vo, 1595, p. 126) and Pliny, following his authority ('Hist. Nat.' edit. Harduin, lib. vii. c. 59), say that the Romans did not begin to shave till the year of the city 454, when Publius Ticinius Mena brought over barbers from Sicily. Scipio Africanus, Pliny adds, was the first Roman who shaved every day. The first day of shaving among the Romans was subsequently considered as the entrance upon the state of manhood, and was kept with festivities like a birth-day. This practice is alluded to by Juvenal ('Sat.' iii. 186). Alexander ab Alexandro ('Genial. Dier.' lib. v. § 18) says the Roman youth consecrated the first fruits of their beards to some god; a custom which is illustrated by passages in Martial, Statius, and other authors.

Augustus, and the Roman emperors his successors, till Hadrian, shaved, as appears by their coins. Hadrian was the first emperor who wore a beard. (See 'Dion. Cassius,' edit. 1750, lib. lxviii. p. 1132.) Plutarch says he wore it to hide the scars in his face. The emperors who followed Hadrian continued to wear beards. (Pancirollus 'de Rebus Memorabilibus,' edit. Francof. 1660, p. 163.) Rasche, however, in his 'Lexicon Rei Num.,' notices the circumstance of Augustus suffering his beard to grow as a mark of grief for the death of Julius Cæsar; and says that certain coins struck about this time at Aria, A.U.C. 710, present the portrait of Augustus bearded. Dion. Cassius, lib. xlviii. (edit. Hamb. 1750, tom. i. p. 551), says that Augustus put off his beard about A.U.C. 717, with great ceremony and feasting. Antoninus Pius and Marcus Aurelius wore lengthened beards as philosophers; though Aurelius, when young, is represented without a beard. Some of the Africans wore long beards, as may be seen upon the coins of Juba. (See Rasche, 'Lexicon Rei Num.' tome ii. p. 2, col. 1018.)

It would require no small space to enter minutely into the history and vicissitudes of the beard among the nations of modern Europe. The Lombards, or Longobardi, derived their name entirely from its length: and Eginhard, the secretary of Charlemagne, informs us that the Merovingian, or first race of French kings, were equally solicitous to nourish its growth; though at a later period among the French it should seem that the common people shaved the whole beard.

The ancient Britons, according to Cæsar ('De Bello Gall.' lib. v. c. 14), wore no beards except upon the upper lip. He probably spoke of the Kentish Britons only, or of the tribes who immediately adjoined them. Strabo speaks of the beards of the inhabitants of the Cassiterides, the Scilly islands, as in his time like those of goats. ('Geogr.' edit. Falconer, Oxf. 1807, fol. lib. i. p. 239.)

Tacitus, speaking of the Catti, one of the ancient German nations, says, from the age of manhood they encouraged the growth of the hair and beard, nor would lay them aside till they had slain an enemy. ('De Mor. Germanorum,' c. xxxi.)

The Anglo-Saxons, at their arrival in Britain, and for a considerable time after, wore beards. In the Anglo-Saxon MSS., St. Dunstan is represented with a beard and whiskers; and on the Great Seal, Edward the Confessor has a pointed beard and moustaches. (See Knight's 'Popular History of England,' vol. i. pp. 136 and 165, where they are copied.) The clergy, however, were very early obliged to shave their beards in obedience to the laws, and in imitation of the practice of all the Western Churches. This distinction between the clergy and the laity subsisted for some time; and a writer of the 7th century complains that the manners of the clergy were then so corrupted, that they could not be distinguished from the laity by their actions, but only by their want of beards. By degrees the English laity began to imitate the clergy so far as to shave all their beards except the upper lip.

The English spies who were sent by Harold to discover the strength and situation of the Duke of Normandy's forces, returned with the account that almost all his army had the appearance of priests, as they had the whole face with both lips shaven. (See Malmesbury, lib. iii.) The Normans, indeed, not only shaved their beards themselves, but when they became possessed of authority, they obliged others to imitate their example. It is mentioned by some of our historians as one of the most wanton acts of tyranny in William the Conqueror, that he compelled the English (who had been accustomed to let the

hair of their upper lip grow) to shave their whole beards; and this was so disagreeable to many of them, that they chose rather to abandon their country than to lose their whiskers. (See 'Mat. Paris,' edit. 1640; 'Vit. Abbat. S. Albani,' tom. i. p. 46.) Ordericus Vitalis, p. 815, relates a curious anecdote of Henry I. submitting to lose his beard at the remonstrance and by the hands of Serlo, archbishop of Sens.

In the higher classes of society the beard, in a greater or less degree, was encouraged by the English for a series of centuries, as is evident from the sepulchral monuments of our kings and chief nobility, and from portraits where they remain. Edward III. is represented upon his tomb at Westminster with a beard which would have graced a philosopher. Stowe, in his 'Annals,' edit. 1631, p. 571, in his account of the reign of Henry VIII. under 1535, says, "The 8th of May the king commanded all about his court to poll their heads, and, to give them example, he caused his own head to be polled, and from thenceforth his beard to be knotted, and no more shaven." The practice of wearing the beard continued to a late period; and the reader will readily call to recollection the portraits of Paulet Marquess of Winchester, Cardinal Pole, and Bishop Gardiner, all ornamented with flowing beards, in the reign of Mary I. In the reign of Elizabeth, beards of different cut were appropriated to different characters and professions. Shakspere, in 'Henry V.,' act. iii. sc. 6, speaks of a "beard of the general's cut." Mr. Knight has remarked on the passage, that "beards of a particular cut had then appropriate names, and were sometimes characteristic of professions. The *steeletto* beard and the *spade* beard appears to have belonged to the military profession; though the cut of particular generals—settlers of the fashion—might vary. Southampton is always represented with the steeletto beard, Essex with the spade beard." The soldier had one fashion, the judge another, the bishop different from both. Malone has quoted an old ballad, inserted in a miscellany entitled 'Le Prince d'Amour,' 8vo, 1660, in which some of these forms are described and appropriated. (See Reed's 'Shaksp.' 8vo, Lond. 1803, vol. xii. p. 399.) Taylor, the Water-Poet, in his 'Whip of Pride,' likewise describes the fashions of the beard as they still continued to subsist in his time:

"Now a few lines to paper I will put,
Of men's beards' strange and variable cut;
In which there's some do take as vain a pride
As almost in all other things beside.
Some are reap'd most substantial like a brush,
Which makes a nat'ral wit known by the bush;
(And in my time of some men I have heard,
Whose wisdom have been only wealth and beard.)
Many of these the proverb well doth fit,
Which says, 'Bush natural, more hair than wit.'
Some seem as they were starch'd stiff and fine,
Like to the bristles of some angry swine;
And some (to set their love's desire on edge)
Are cut and pruned like to a quickset hedge.
Some like a spade, some like a fork, some square,
Some round, some mow'd like stubble, some stark bare;
Some sharp, stiletto-fashion, dagger-like,
That may with whisp'ring, a man's eyes outpike;
Some with the hammer-cut, or Roman T,
Their beards extravagant reform'd must be;
Some with the quadrate, some triangle fashion,
Some circular, some oval in translation;
Some perpendicular in longitude,
Some like a thicket for their crassitude.
That heights, depths, breadths, triforme, square, oval, round,
And rules geometrical in beards are found.
* * * * *
The barbers thus (like tailors) still must be
Acquainted with each cut's variety."

The beard now gradually declined, and the court of Charles I. was the last in which even a small one was cherished. After the restoration of King Charles II., moustachios or whiskers continued, but the rest of the face was shaven; and in a short time the process of shaving the entire face became universal.

The beard went out of fashion in France in the reign of Louis XIII., and in Spain when Philip V. ascended the throne. In Russia it continued somewhat longer. Butler, in his 'Hudibras' (part ii. canto i.), alludes to the beard "cut square by the Russian standard." Dr. Giles Fletcher, in his 'Treatise of Russia,' observes, "that the Russian nobility and quality accounting it a grace to be somewhat gross and burly, they therefore nourished and spread their beards to have them long and broad. This fashion continued among them till the time of the Czar Peter the Great, who compelled them to part with these ornaments, sometimes by laying a swingeing tax upon them, and at others by ordering those he found with beards to have them pulled up by the roots, or shaved with a blunt razor, which drew the skin after it, and by these means scarce a beard was left in the kingdom at his death: but such a veneration had this people for these ensigns of gravity, that many of them carefully preserved their beards in their cabinets, to be buried with them, imagining perhaps that they should make but an odd figure in the grave with their naked chins."

Within the last fifty years, however, the beard has made its reappearance in most European countries, and with it the moustache and whiskers. Its first use would seem to have been in the French army during the rule of Bonaparte; from thence it extended to

civilians; then to Italy; then to Germany; then to Spain and Russia; and, lastly, to England, where, though yet far from general, it is evidently on the increase. Its retention has been advocated by some medical men as conducing to health; and while the British army was in the Crimea, directions were issued to allow the soldiers to wear their beards, which they are still allowed to, with certain restriction.

The reader who desires further information on the history of beards may consult the lexicons of Hoffmann and Pitiscus for the classic times; and in Bulwer's 'Anthropometamorphosis, or Artificial Changeling,' 4to, Lond 1653, pp. 193-216, scene xii. is a whole chapter 'On the opinion and practice of diverse nations concerning the naturall ensigne of manhood appearing about the mouth;' quoted from innumerable authors, ancient and modern.

Shaving the beard in derision was, throughout the East, considered to be the greatest mark of ignominy which could be inflicted upon an enemy (2 Sam. x. 4, 5); and to pluck a man's beard was the highest mark of insult. The Eastern origin of some of our old romances is, perhaps, in no circumstance more visible than in the descriptions which are so frequently given of giants cutting off the beards of princes who fell into their hands. Drayton alludes to this practice in his 'Polyolbion,' Song iv.:

> "And for a trophy brought the giant's coat away,
> Made of the beards of kings."

Beards were considered to be of great use in enchantments. Spenser ('Faerie Queene,' book vi. canto i. v. 15) tells of the lady Briana, who to her suitor

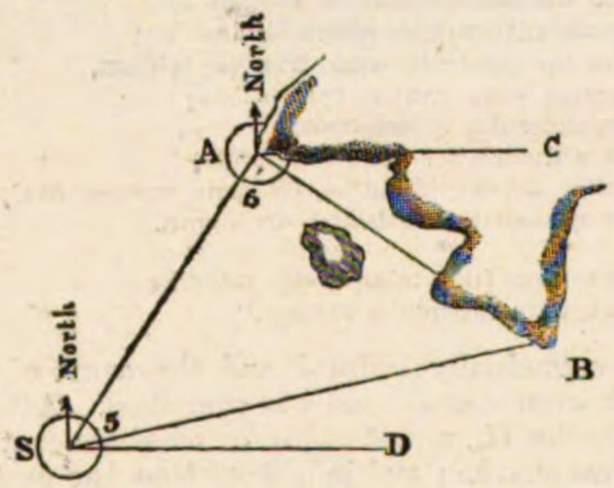
> "Refused had to yield her love againe,
> Untill a mantell she for him do fynd,
> With beards of knights and locks of ladies bynd."

The suffering of the beard to grow in the time of mourning is a custom which has been already incidentally alluded to. Levi, in his 'Succinct Account of the Rites and Ceremonies of the Jews at this present time,' 8vo, Lond., says, that for the seven following relations, namely, a father or mother, brother or sister, son or daughter, husband or wife, they must not shave their beards, nor cut their nails neither of their hands or feet, nor bathe for the term of thirty days; which term is called in Hebrew *Shyloshim*, which means thirty days.

To beard, in modern English, means to set at defiance, to oppose face to face in a hostile manner. Shakspere, in 'Henry IV.,' act. iv. scene 4, makes Douglas say,

> "No man so potent breathes upon the ground
> But *I will beard him*."

BEARING, the direction of the line drawn from one point to another. It is a term usually applied to the points of the compass, as follows: If the line B A be in a N. W. direction from B, A is said to *bear* N. W. of B, or the *bearing* of A is N. W. To take *bearings* is to ascertain the points of the compass on which objects lie. The following example will serve to familiarise the word, by connecting it with a simple problem of trigonometry:



Cape B is twenty miles from Cape A, and bears S. E. of it. On board a ship S, Cape A is observed to bear N.N.E., and B bears E. by N.: required the position of the ship. Draw S D, A C, both east; then the angle D S B is one point of the compass, and the angle D S A six points: consequently, A S B is five points of the compass, or 56° 15′; but C A S and A S D are together equal to two right angles, or sixteen points, of which A S D is six points, therefore C A S is ten points; but C A B is four points, therefore S A B is six points, or 67° 30′; therefore, in the triangle A B S, the side A B and two angles are known, whence the other sides, or the ship's distance from the two capes, can be found. The easiest method of solving this problem is by actual construction, the results of which are generally as accurate as the data.

In a manner somewhat similar, the distance of a ship from a headland might be found by observing its bearings at two different hours of the day, and knowing the course and the distance sailed in the intermediate time. If all the bearings are by compass, as in the second problem, the magnetic variation need not be allowed for, because all the bearings are equally wrong; but if one or more be true bearings taken from a map, as in the first problem, then the bearings observed by the compass must be corrected. [Azimuth; Compass, Azimuth.]

The above diagram is a sufficient illustration of the purpose to which "bearings" apply at sea: it remains to describe *the manner in which such are to be observed*. Of late years considerable improvement has taken place in the mode of obtaining bearings at sea. The oscillation of the compass card was long an impediment to accuracy, and observations in azimuth could only be relied on to within a quarter of a point; but the improvements in compasses [Compasses], the increased size of merchant shipping, and the extended use of steam as a propeller, including increase of speed, have affected "navigation" to such an extent, that it will be a legitimate object in this Cyclopædia to condense within certain limits all that is known in nautical science up to the present,—all that is of public or general interest in that subject.

The operation of observing a bearing of a distant object has consisted in bringing the two sight vanes of an azimuth compass [Compass, Azimuth] in a line with the object, and then reading off the degree upon the compass card. If two objects were to be observed, the same operation was repeated with the second, and the difference in degrees or points of the compass gave the contained angle, and a good azimuth compass on shore would, on ordinary occasions, afford sufficient accuracy; but it is difficult at sea, even to a practised navigator, when a ship and the card have much motion, to catch the intersection of the object with the sight vanes at *the very time* of estimating or reading off the degree which then precisely faces the "lubber-line" of the instrument. And a highly experienced nautical surveyor has shown ('Nautical Mag.') that on frequent occasions the usual position of the azimuth or standard compass unfits it for *convenient* use. It is, indeed, placed so high above the deck on board iron ships or steamers, that an improvement in the method of taking a bearing was called for. Accordingly, Captain Becher, R.N., described a "dumb card," for general use; and a veteran and experienced officer, Lieut. Friend, F.R.S., invented and patented a species of dumb card, which he calls a "Pelorus." The navigator gains herefrom these great advantages; namely, his attention is not distracted by two observations, *which ought to be simultaneous;* but while he "sets" the distant objects by the sight-vanes of the Pelorus, his assistant, at a preconcerted signal, reads off the degree on the compass card. And again: it often happens that an island or headland is visible from aloft, but not so from the deck; in such cases, from the circumstance of the Pelorus, or dumb card, having no magnetic needle, it can be used with equal facility even in a ship's top-gallant cross-trees, if desirable, thus avoiding all considerations of attraction from contiguous chain-gear; and all that is necessary is for the observer to set the side of the square box of the instrument parallel to the fore-and-aft line of the ship, and at the moment of making the observation to raise a hand or the voice, when the man at the binnacle (by previous arrangement) records the bearing of the ship's head at the precise moment; and the bearing of the ship's head, compared with the angle which the object makes with the ship's head by Pelorus, will be the bearing of the object. For example: An object is seen to bear, by Pelorus or dumb card, 45° on the starboard bow, while the ship's head, by the binnacle, was N. by W. The difference between N. by W. and 45°, or four points eastward, will extend to N. E. by N. (the bearing of the object). The value of these instruments is increased by the introduction of another very recent discovery in astronomical science [Spherograph]; and they are likely to be of immense importance in navigating foggy districts, inasmuch as a good bearing of the sun in a mist by day, or of a star or planet by night [Horizon], obtained by a Pelorus, gives, in connection with the Spherograph, a good and reliable approximate latitude, &c., dispensing with the altitude. [Dead Reckoning.]

Another recent change in the mode of taking bearings bids fair to prove extensively useful to navigators, and especially in iron ships or steamers. A well-known and experienced London merchant-captain, Charles Robertson, has invented and patented a "Deviation Detector." It is simply a brass arrow-shaped index, with a pin through its centre extending downwards and dropping into a hole in the centre of the covering-glass of a ship's compass. The pin is long enough to stand some three or four inches above the arrow, and by means of a joint in it admits of its being elevated or depressed vertically, as convenient. On the sun's *true* bearing being known by calculation (or by the spherograph), the arrow point is turned so that the *shadow* of the pin falls along the axis of the arrow, when the difference between the arrow point and the degree beneath it on the compass card marks at once the absolute error of the compass (including both deviation arising from terrestrial magnetism and the effects of local attraction).

For example: Suppose calculation, or "inspection," informs me that, at a given moment, the sun bears truly S.W. On turning the arrow point towards the sun, so that the shadow of the pin lies on the axial line, if the part of the compass card immediately under the arrow point reads S.W., the compass has no error, because then the *true* and *magnetic* bearings coincide; but if the card read S.S.W., and the *true* bearing (by the arrow point) read S.W., there will evidently be an error of two points of the compass. The importance of the instrument (simple as it is) may be inferred from the numerous and varied attempts which have long been made, to apply the principle in various forms in navigating an iron ship or steamer.

BEATIFICATION, an act by which the pope declares a "servus Dei," that is, an individual who died in good repute as a virtuous and holy man, to be beatified or blessed after death; that prayers may be

addressed to him, and his image be placed on the altar within the limits of some diocese, province, or town, or within the houses of the religious order to which the deceased belonged, defining at the same time the peculiar mode of worship allowed by prayers, masses, &c., until the time he may be duly canonised as a saint, to which beatification is a step. His relics may thenceforth be exposed, his image is crowned with rays, but neither are carried in procession; and though a special office is appointed in the Church service, the day of the office is not an obligatory festival, and it has no octave. The distinction between beatification and canonisation is this: The first is a mere permission to honour and worship, and the object of this veneration is styled Beatus, in which the pope does not act as a judge to decide on the condition of the person beatified; while in canonisation this is done, and an injunction is given to venerate the object of it as a saint, "Sanctus," acknowledged by the whole Church. Originally it was the bishop of the diocese who allowed the veneration or worship of deceased individuals whom he deemed worthy of it; and when the worship extended to other dioceses, and by degrees to the Church in general, "with the consent, tacit or expressed, of the supreme pontiff," then the worship, which was before that of simple beatification, acquired the character of canonisation. But when, in after times, the question both of beatification and canonisation was referred to the Roman see, the pontiffs, in granting the first, always made the distinction: "dummodo propter præmissa canonizatus, aut canonizata, non censeatur." (Benedicti XIV. 'Opera,' vol. i. 'De Servorum Dei Beatificatione.') In the same chapter Benedict XIV. determines the regulations as to the proceedings, evidence, &c., to be gone through previous to granting the writ of beatification. It may be granted to two classes of individuals, martyrs and confessors. After beatification has been obtained, a new suit and fresh evidence of sanctity are required in order to obtain the canonisation of the same individual. In May 1807, five Beati were canonised, or declared saints, in St. Peter's church, by Pius VII. The ceremony is very expensive, and therefore is not performed very frequently. It is only since the pontificate of Alexander VII. that the ceremony of beatification has been performed in St. Peter's church, with great solemnity; St. Francis de Sales, in Jan. 1662, being the first whose beatification was solemnised there. Applications for the honour of beatification are generally made by the friends or relations of the deceased, or by the brethren of the religious order of which he was a member; evidence of his conduct and merits is collected and laid before a congregation of cardinals and prelates; counsel is employed by the applicants, while another counsel opposes the petition, and endeavours to find flaws in the evidence. This latter office is performed by a legal officer of the Roman see, who has been nicknamed *l'Avvocato del Diavolo*, "the devil's advocate," as he performs what is considered an ungracious part, by opposing the admission of a candidate into the category of the saints.

BEATS, in Music (a term always used in the plural), are the pulsations, throbbings, or beatings, resulting from the joint vibrations of two sounds of the same strength and nearly of the same pitch; that is, of two sounds differing but little, if at all, in intensity, and which are almost, but not exactly, in unison. When two organ-pipes or two strings sounded together, are nearly, but not accurately, of the same pitch, that is, are not in perfect tune, they produce throbbings that may be compared to the rapid beating of the pulse; and to these Sauveur, the discoverer of the phenomenon, applied the term *battemens*, or beats, which has since been adopted by all writers on the subject.

Mr. Woolhouse in his 'Essay on Musical Intervals, Harmonics, &c.' London, 1835, says "Beats originate in the slight perturbation of the periodic coincidences of the vibrations which take place with the perfect chord, which perturbation makes one of them gain a little upon the other at these successive places of coincidence: and as soon as this small gain brings two consecutive vibrations about to another coincidence, a long cycle of the vibrations will be completed, and they will begin and perform a similar long cycle in the same manner, and so on. The coincidences at the beginning and end of these cycles are the times when the beats are heard, and consequently the time of the cycle is the same as that between two consecutive beats. They seem to be caused by the mutual concurrence of the vibrations in setting the particles of the surrounding air in motion, which makes the joint sound more loud at the places of coincidence, though not with sufficient frequency to produce the sensation of a continued sound."

Dr. Smith has, in his 'Harmonics,' entered fully into the subject of *beats*, and founded hereon his well-known system of temperament. [Temperament.] In his ninth proposition he says, that "if a consonance of two sounds be uniform without any beats or undulations, the times of the single vibrations of its sounds have a perfect ratio; but if it beats or undulates, the ratio of the vibration differs a little from a perfect ratio, more or less, according as the beats are quicker or slower." His experiment in demonstration of this is practical, easy, and satisfactory. "Change," says Dr. Smith, "the first string of a violoncello for another about as thick as the second. Then screw up the first string, and while it approaches gradually to a unison with the second, the two sounds will be heard to beat very quick at first, then slower and slower, till at last they make a uniform consonance without any beats or undulations. At this juncture, either of the strings struck alone, by the bow or finger, will excite large and regular vibrations in the other, plainly visible; which show that the times of their single vibrations are equal." For the vibrating motion of a musical string puts other strings in motion, whose tension and quantity of matter dispose their vibrations to keep time with the pulses of air propagated from the string that is struck; a phenomenon explained by Galileo, who observes, that a heavy pendulum may be put in motion by the least breath of the mouth, provided the puffs be often repeated, and keep time exactly with the vibrations of the pendulum. "Alter the tension," continues Dr. Smith, in pursuing his experiment, "of either string a very little, and the sounds of the two will beat again. But now the motion of one string struck alone makes the other only start, exciting no regular vibrations in it; a plain proof that the vibrations of the strings are not isochronous." And while the sounds of both are drawn out with an even bow, not only an audible but a visible beating and irregularity is observable in the vibrations, though in the former case the vibrations were free and uniform. Now measure the length of either string between the nut and bridge, and when the strings are perfect unisons, mark, at the distance of one-third of that length from the nut, one string with a speck of ink. Then place the edge of the nail on the speck, or very near it, and press the string, when, on sounding the remaining two-thirds with the other string open, a uniform consonance of fifths will be heard, the single vibrations of which have the perfect ratio of 3 to 2. But on moving the nail a little downwards or upwards, that ratio will be increased or diminished; and in both cases the imperfect fifths will beat quicker or slower, accordingly as that perfect ratio is more or less altered.

Dr. Young remarks of *beats*, that they furnish a very accurate mode of determining the proportional frequency of vibrations, when the absolute frequency of one of them is known; or the absolute frequency of both, when their proportion is known; for the beats are usually slow enough to be reckoned, although the vibrations themselves can never be distinguished. Thus, if one sound consists of 100 vibrations in a second, and produces with another acuter sound a single beat in every second, it is obvious that the second sound must consist of 101 vibrations in a second. (Young's 'Philosophy,' i. 390.)

In tuning unisons, as in the case of two or more pipes or strings, the operator is guided by beats. Till the unison is perfect, more or less of beating will be heard, as the sounds more or less approach each other. "When the unison is complete," observes Sir John Herschel, "no beats are heard: when very defective, the beats have the effect of a rattle of a very unpleasant kind. The complete absence of beats affords the best means of attaining by trial a perfect harmony. Beats will also be heard when other concords, as fifths, are imperfectly adjusted." (Herschel on *Sound*.)

Dr. Smith, in the learned work of which we have here availed ourselves, gives some useful practical rules for tuning by means of beats, the substance of which will be found under the head of Tuning.

BEAUTY is that quality in visible objects in consequence of which their colours and forms are agreeable to the human mind. The word *beauty* (as Mr. D. Stewart observes, 'Essay on Beauty,' c. ii.) was first applied to objects perceptible by the sight; and, by an easy transition, it has been extended to objects perceptible by the hearing; as when we speak of beautiful music, a beautiful tune, voice, &c. The instances of words which properly signify an impression on one sense being used to signify an impression on another sense are very numerous: thus we sometimes pass from the sight to the touch, as when we speak of lightness or heaviness of form and of colour; from the touch to the hearing, as a sharp, piercing, thrilling, penetrating, or heavy sound; from the touch to the smell, as a pungent smell; from the touch to the sight, as harsh and soft colouring; from the hearing to the sight, as monotony of colour, tone of a picture, harmony of colours; from the taste to the sight, as mellow colouring; from the taste to the hearing, as sweet music.

This proneness to transfer words from one object of sense to another does not, however (as Mr. Stewart remarks), explain why the word *beauty* should be extended only to agreeable *sounds*, and not to agreeable *tastes* or *odours*. That, however, there is a closer affinity between the perceptions of sight and hearing than between those of sight and any other sense, it is not difficult to perceive; and the fact is satisfactorily traced by the same writer to the following causes:—1. The *picturesque* effect which custom, in many instances, gives to sounds; as when a tune calls up the image of a person's home or the haunts of his childhood. 2. The *expressive* power of sounds, as in the case of the human voice, when the expression of the countenance corresponds with the tones of the voice and the meaning of the words which it utters. 3. The significant power of sounds, in consequence of conventional speech. In this way they every moment present pictures to the imagination; and we apply to the description as to the thing described (with hardly any consciousness of speaking figuratively) such words as *lively, glowing, luminous, splendid, picturesque*. "To these considerations should be added (as the same writer justly observes), as a cause conspiring powerfully to the same end, the intimate association which, in our apprehensions, is formed between the eye and the ear, as the great inlets of our acquired knowledge, as the only *media* by which different minds can communicate together, and as the organs by which we receive from the material world the two classes of pleasures which, while they surpass all the rest in variety and in duration, are

the most completely removed from the grossness of animal indulgence, and the most nearly allied to the enjoyments of the intellect. The unconsciousness we have in both these senses of any local impression on our bodily frame may perhaps help to explain the peculiar facility with which their perceptions blend themselves with other pleasures of a rank still nobler and more refined." (Ibid. c. vi.)

But although the epithet *beautiful* is never applied to the perceptions of any sense except those of seeing and hearing, yet it is extended to the results of some intellectual processes, as when we speak of a beautiful chain of reasoning, a beautiful poem, a beautiful metaphor, a beautiful language, a beautiful machine, a beautiful contrivance of nature, &c. When the word *beauty* is thus employed, it is merely a vague term of praise, and is nearly synoymous with *admirable*. "The word beauty (as Mr. Knight remarks) is often applied to a syllogism or a problem; but then it means clearness, point, or precision or *whatever else be the characteristic excellence of that to which it is applied*." ('Inquiry into the Principles of Taste,' p. 259.) As the effect of beauty in visible objects is to produce admiration, all beautiful objects are also admirable; and thence it was an easy step to apply the epithet beautiful to things which produced admiration, although this feeling did not arise from the cause which produces it in the contemplation of visible objects. Similar transfers may be observed in other words: thus the word *law* properly signifies a general command given by one intelligent being to another; but because the *effect* of such a command is to produce an uniformity of conduct in the persons to whom it is addressed, the term *law* has been extended to those operations of nature in which an uniformity of phenomena prevails, although the *cause* of the uniformity is altogether different. [ANALOGY.]

In the following remarks on the nature and causes of beauty, we shall limit ourselves to the original and appropriate meaning of the word in question, namely, the beauty of *visible objects*.

The beauty of visible objects consists of two parts, namely, the *beauty of colour* and the *beauty of form*, which, although closely connected with each other, arise from different sources, and from sources of a different character, inasmuch as the one appears to be, in most cases, a simple emotion, and therefore an ultimate fact, of which no explanation can be given, while the other is a pleasure derived from association, which is susceptible of analysis.

There cannot, in our opinion, be any doubt that certain colours, and certain arrangements of colours, are naturally, and in themselves, pleasing to the eye. Children are observed to take delight in brilliant colours before they have learnt to connect any agreeable ideas with them. The analogy of the other senses would, *à priori*, lead to this conclusion: for as there are certain odours, tastes, and sounds, which are naturally pleasing or displeasing to the nose, the tongue, and the ear, so it may be presumed that there are certain colours, and combinations of colours, which are naturally pleasing or displeasing to the eye. Although, as will be presently shown, one branch of beauty is entirely founded on association, the feeling of beauty cannot be derived from association *alone*. "It is the province of association (as Mr. Stewart has justly observed) to impart to one thing the agreeable or disagreeable effect of another; but association can never account for the *origin* of a class of pleasures different in kind from all the others we know. If there was nothing originally and intrinsically pleasing or beautiful, the associating principle would have no materials on which it could operate." ('Essay,' i. c. 6.)

This origin of the feeling of beauty appears to us to consist in the pleasure derived from the contemplation of colours, a pleasure, in most cases, purely sensual and organic, and as incapable of explanation as the pleasure derived to the mind through the medium of the ear from the harmony of sweet sounds. An instance of purely sensual beauty is afforded by *precious stones*, which all ages and nations, ancient and modern, barbarous and uncivilised, have agreed in admiring. That their beauty does not arise from any collateral associations of their durability and hardness is evident from this, that in the unpolished state, when they are equally hard and durable, they excite no admiration. The precious *metals* also are beautiful for the same reason; though they have other qualities besides their beauty which give them exchangeable value: whereas the value of precious stones is almost exclusively owing to their beauty. Flowers, the plumage of birds, the rainbow, the setting sun, the clear blue expanse of the sky or the sea, also derive their beauty in great measure from the mere sensual impression on the organ of sight. Indeed, there are only a few cases (such as that of the beauty of complexion, which will be mentioned below), in which the beauty of colour is derived from association, and therefore admits of a resolution into simpler elements.

The beauty of *form* belongs altogether to a different category, and is derived (as we shall attempt to show) from an association inseparably connected with the form of any object, and necessarily and instantaneously suggested by it, namely, its adaptation to the purpose which it is intended to fulfil. The beauty of form, as arising from this source, is however subject to certain conditions, the chief of which is, that the object should either possess the beauty of colour, or at least should be of such a colour as is completely inoffensive to the eye. The beauty of form, although in strictness not connected with the colour of any object, is nevertheless so far dependent on it, that if the colour should be offensive to the eye, the pleasure derived from the beauty of form is much impaired, or is even destroyed. Beauty of form as

arising from the fitness of the form for its end, requires that the colour of the object should be such as shall not interfere with the effect produced by the mutual relations of its parts.

There is, however, another condition for the existence of beauty of form, beyond the perception of its fitness to its purpose, the statement of which will complete our definition of this kind of beauty. If, then, those colours are either absent or present, whose absence or presence is essential to the perception of beauty in any object, simply as an organic impression, the beauty of form in any object mainly depends on our sense of its adaptation to the end for which it is destined, provided that this end is *agreeable to contemplate*, and is such that the mind *dwells on it with pleasure*. Hence the form of the antelope, the swan, or the tiger, is considered beautiful, because we take a satisfaction in contemplating the movements which those forms are admirably fitted to produce; but the form of the pig's snout is not considered beautiful, because the mind flies with disgust from the filthy purposes for which that animal employs it. So likewise we call the outward form of the arms, legs, neck, &c., of the human figure beautiful, when their form is suited to their respective uses; but no one (except perhaps an anatomist) finds any beauty in the form of the human stomach, or intestines, or liver, though equally well fitted for their several ends, because they suggest the notion of processes which men do not willingly contemplate. (Burke's 'Sublime and Beautiful,' part iii. s. 6—8.)

Perhaps, in strictness, it might be thought that the simple emotion derived from the *colour* of objects is alone properly entitled to be considered as the feeling of beauty; and that the beauty of *form* in any object, derived from a sense of its fitness to its end, is only a pleasing association, allied indeed to the feeling of beauty by a close analogy, but still distinct from it. This question (which in fact is merely verbal) we have not sufficient space to discuss at length; nevertheless it appears to us that all ages and nations have agreed in speaking of the beauty of *form* as well as of *colour*, and that we are justified in considering as included in the feeling of beauty those emotions which are susceptible of analysis, as well as those which are not.

Having made these general remarks, we will proceed to explain, with somewhat more detail, the application of the principles last stated.

The *beauty of form*, arising from a perception of utility or of fitness of certain means to produce a certain end, may be observed both in animate and inanimate objects—in the works both of nature and of art. In animate beings we are gratified by the recognition that a certain form is suited to the wants of the animal, and that certain desired effects or motions are produced with ease and little effort. It is on this principle that we admire the beauty of the human form, every part of which is perfectly fitted for its intended purposes, and that we admire the motions of a horse, a stag, a greyhound, or a cat, as being made without any apparent trouble or difficulty, and as the result of a power which accomplishes its end with the least possible expense of exertion. The same feeling which makes us take pleasure in movements and forms which indicate ease, leads us likewise to dislike those which express constraint and toil; hence, both in nature and art, all forced and laboured attitudes, all tension of muscle, all visible and overstrained efforts to produce a certain effect, or to express a certain feeling (which is the source of affectation in art), are offensive to the taste. And thus all angular and jerking action, and all heavy dragging of the limbs, are devoid of beauty, as being signs of violent and toilsome effort, and as equally removed, though in contrary ways, from that equable, flowing, and easy motion in which grace consists. Nor is it only in animals that the marks of ease are agreeable to us; the varied, flowing, and irregular outline which characterises the free growth of plants, is beautiful on the same principle. It was the perception of this fact which induced Hogarth to imagine that beauty of outline consists in its serpentine direction, which is true of those animate and organised beings whose wants require them to assume this shape; but does not apply to other objects, such as buildings or walks, in which convenience requires a straight or angular form, and in which a straight or angular form is therefore beautiful. The beauty of *proportion* or *symmetry* in the forms of animals is likewise derived from a sense of utility; for it is manifest that small limbs would not suit the wants of a large body; that a large foot would be an incumbrance to a small leg; that a large hand would be an incumbrance to a small arm, &c. For the same reason different animals have different proportions, as their bodies are formed on different scales and adapted to different purposes; and thus the form or size which is beautiful in one animal would be monstrous in another, as if the long neck of the camelopard, an animal living on the leaves of trees, were given to the lion, whose teeth and claws are adapted to seizing and tearing the flesh of animals; or if the antlers of a stag were fixed on the forehead of a dog. (Horace, 'De Arte Poet.,' at the beginning; on some exceptions to this principle, see Hogarth's 'Analysis of Beauty,' c. 6; Müller's 'Archæologie der Kunst, § 24.) And thus the limbs of the human body, or the features of the human face, are beautiful only in their proper places, when they are taken in combination with the other parts of the body, and so manifestly suggest the notion that they are fitted to perform their respective offices.

"'Tis not a lip or cheek we beauty call,
But the joint force and full result of all.

All incongruous combinations in animate beings are contrary to beauty: for example, the pink and white complexion, which suits the delicacy and weakness of the female form and character, is less becoming to man, than the dark-red and brown, which characterise the sun-burnt cheek of a person accustomed to rural labours, to athletic exercises, to field-sports, and to a military or naval life. Somewhat feminine forms and colours are occasionally admired in very young men; and in women, as in the natives of the South of Europe, a dark complexion is often extremely beautiful: but an effeminate appearance is not more approved in men than an effeminate mind; and muscular or athletic forms in women are commonly considered coarse and clumsy, a judgment confirmed by the taste of the Greek artists, who, in representing Diana as a huntress, with her dogs, her arrows, and her garments girded up for running, never give her a masculine form; as, in their representations of Apollo, though they avoid muscularity, they carefully guard against the roundness and softness of limbs which are proper to female beauty. [APOLLO.]

Hence the *middle* form in the different species of animals is the most beautiful; that is to say, it is that abstract form at which the painter or sculptor arrives by rejecting all the faulty extremes, and which he takes as the type from which the varieties of individuals diverge in different directions. Thus the most beautiful size in man is between a giant and a dwarf; or, to take an instance in a single feature, the most beautiful form of the nose is when the outline is straight; any deviation from this form on either side, so as to make it like that of the fauns in Greek sculpture, or to give it a protuberance, is injurious to the beauty of the human countenance. (See Müller, 'Archæol. der Kunst.' § 329, n. 5.) And as it is with the general form of the human race, or of the several limbs and features, so is it with particular classes. Thus, "though the forms of childhood and age differ exceedingly, there is a common form in childhood and a common form in age, which is the more perfect as it is the more remote from all peculiarities." (Reynolds' Discourse 3.) Reynolds, however, is mistaken when he says that the middle form is beautiful because it is the most common (see 'Idler,' No. 82); for, as has been truly remarked, there are many forms of frequent and ordinary occurrence, which are by no means beautiful. The beauty of the middle form arises from its being that which is the most suited to the purposes and wants of the animal: thus, if a nose, a mouth, or an eye was very much above, or very much below the average size, it would either be inconvenient from its magnitude, or incapable of performing its functions on account of its smallness. Having once established this maxim in our minds, we forget, as in many other instances, the principle on which it is founded; and although a nose, for example, would be equally fitted for its purposes if it deviated slightly from the straight line, yet we consider that line alone as the standard of ideal beauty.

The reason why we are gratified by the perception of congruity or fitness in the general structure of an animate body and of its several component parts, by the appearance of ease and grace in the movements of animals, and universally by all the marks of activity, vigour, energy, and health, is that we are gratified by the absence of suffering, as we are pained by its presence; as when a person not hardened by custom to such sights witnesses an execution, a surgical operation, the slaughter of animals, a field of battle covered with the dead and dying, a hospital, &c. Hence all those objects which suggest the notion of pain, discomfort, or decay, are devoid of beauty. Such is the case with animals, as the elephant or the hippopotamus, which are heavy and cumbrous in their shape, and appear to drag their limbs with difficulty and effort; suggesting none of those impressions of joy and satisfaction in the animal, exulting in its strength and agility, which are occasioned by the unshackled movements of the horse, the antelope, or the stag. (See the comparison of the horse at the end of the 6th Iliad.) Hence, likewise, all deformity in animals is inconsistent with beauty, and is ugly in proportion as the shape of the limb or body deviates from the standard form, and is unfitted for the purposes for which it is intended.

For the same reason that deformity in animals is inconsistent with beauty, all appearance of disease, decay, and death is loathsome and hideous: as the ghastly look of a bleeding wound, the convulsive movements of agony, the pale, livid, or emaciated countenance of a person expiring under the rapid progress of a pestilential disease, or wasting away with famine, atrophy or consumption, the mouldering remains of a dead body, or the empty frame of a skeleton. Hence, when Romeo is described by Shakspere as descending into the vault, in order to see Juliet's corpse, he says, on discovering that the bloom had not faded from her face,

> "O my love! my wife!
> Death, that hath suck'd the honey of thy breath,
> Hath had no power *yet* upon thy beauty.
> Thou art not conquered: beauty's ensign yet
> Is crimson in thy lips, and in thy cheeks,
> And death's pale flag is not advanced there."

The same feelings are transferred by us to the vegetable kingdom, though with a great dimunition of their intensity: thus the yellow or brown colour of the faded leaf is for the most part less beautiful than the brilliant and vivid green of spring and summer vegetation; nevertheless, there is probably no person at all alive to the beauties of external nature who has not admired the rich and varied tints of an autumn landscape, produced by the irregular discoloration of the leaf. When, however, decay has completed its work, all beauty vanishes; and a tree quite bared of its leaves has nothing more to recommend it to the eye than if it were actually dead. And when a tree has through age or by accident undergone a partial decay, its beauty is impaired, though its wreck may still suggest agreeable notions of power and grandeur, the memory of former vigour, of resistance to time and the elements, or to the destructive agents of nature. Such are in part the feelings excited by the sublime picture of Milton:—

> "As when heaven's fire
> Hath scathed the forest oaks or mountain pines,
> With singed top their stately growth, though bare,
> Stands on the blasted heath."

In general, however, all appearance of poverty, meagreness, or decline of vegetation is, unless compensated by countervailing circumstances, unfavourable to beauty. (See Price's 'Essay on Beauty,' p. 29.)

The beauty derived from a perception of utility is not confined to the works of nature, but is common to the works of constructive art, in which the adaptation of means to ends is equally observable, and in which there is a similar correspondence of the constituent parts. Thus in buildings each different part has a manifest and visible purpose—as the column to support a weight on the ground, the arch to support a weight over an opening, the windows to admit light and air, the projection of the roof to throw the rain-water from the walls, &c. Every part of a building has therefore its peculiar form and beauty, dependent on its destination. And the same is the case with different *kinds* of building: the disposition of parts which would be beautiful in a church or a palace, would be displeasing and absurd in a cottage or a fortified castle. "Grecian temples, Gothic abbeys ,and feudal castles," says Mr. Payne Knight, "were all well adapted to their respective uses, circumstances, and situations: the distribution of the parts subservient to the purposes of the whole; and the ornaments and decorations suited to the character of the parts, and to the manners, habits, and employments of the persons who were to occupy them; but the house of an English nobleman of the 18th or 19th century is neither a Grecian temple, a Gothic abbey, nor a feudal castle; and if the style or distribution, or decoration of either be employed in it, such changes and modifications should be admitted as may adapt it to existing circumstances; otherwise the scale of its exactitude becomes that of its incongruity, and the deviation from principle proportioned to the fidelity of imitation." ('On Taste,' part ii. ch. 2. § 54; see also Lord Aberdeen on 'Grecian Architecture,' p. 26-35.)

For a similar reason, all ornament in architecture should be subordinate to use, and should grow out of and be suggested by it; whence professed architects, with whom the idea of decoration is predominant, often fail in their attempts to produce beauty, and in many cases seem rather to adapt the building to the ornaments than the ornaments to the building. Accordingly, it may be observed, that engineers whose attention is solely directed to the *use* of that which they plan, often construct more *beautiful* buildings than persons with whom beauty is the chief consideration. And generally, it may be observed, that all ornament, if accumulated to an excessive degree, either from a love of gaudy magnificence, or for the sake of ostentation, is devoid of beauty.

For the same reason that neatness, freshness, and regularity are pleasing to us in buildings, as being associated with the ideas of comfort and enjoyment, "we require," as Mr. Knight has observed, "that immediately adjoining the dwellings of opulence and luxury, everything should assume its character, and not only be, but appear to be, dressed and cultivated. In such situations, neat gravel walks, mown turf, and flowering plants and shrubs, trained and distributed by art, are perfectly in character" (ii. 2. 29). In laying out the direction of roads or walks, the beauty of the line is likewise determined by its fitness. Thus, in an open and level plain a straight line is most agreeable to the eye; in broken and irregular ground, the line which adapts itself to the shape of the country, by constantly keeping the same level, is to be preferred. The pleasure which is felt in following the windings of a road carried through a mountain-pass, and creeping round the declivities of the rocks, is enhanced by a sense of skill in the contriver and executor, and of difficulty successfully overcome.

The beauty of furniture and dress is likewise in a great measure derived from their *fitness;* though, with regard to dress in particular, our taste is liable to be determined by many independent, and often conflicting considerations, as novelty, fashion, &c., some of which will be mentioned below. Symmetry of parts, which the eye often so rigidly exacts in architecture, in gardening, in the internal decoration of a house, in dress, &c., arises in great measure from a sense of utility: thus, for example, in the construction of a house, the entrance is obviously best placed in the centre of the wall, as it affords the easiest communication to the various parts of the building; the windows are most convenient if they are at nearly equal distances from each other, and are not crowded together in some places and separated by wide intervals in others; the columns best perform their work if they are separated by equal spaces, and therefore support equal weights. The pleasure derived from symmetry in works of art is however not confined to its *beauty,* but in part arises from the evidence which it affords

of an uniform and extensive plan having been conceived and executed, and in part from that satisfaction which we take in the perception of resemblances, as well in outward objects as in the efforts of wit and imagination. It was probably the latter feeling (combined however with an excessive attempt to imitate in the garden the forms of architecture) which gave rise to the style of gardening described by Pope, in which

> "Grove nods at grove, each alley has its brother,
> And half the platform just reflects the other."—(*Epist.* 4.)

This formal style of gardening was founded on a just sentiment of what is suited to the immediate neighbourhood of a house, both in respect to the comfort of the inhabitants and the agreement with architectural forms; but in clipping shrubs into unnatural and fantastic shapes, and in laying out the ground in over-minute and complicated patterns, it sometimes carries a just principle to a vicious excess. (See Walpole's history of the modern taste in gardening, in his 'Anecdotes of Painting;' and Whately 'On Gardening,' § 139—47.)

The garden, in fact, forms the *transition* from the forms of architecture to those of landscape, and is a sort of middle term by which the hard, angular, and precise forms of art are melted into the flowing, irregular, and infinitely varied outlines of nature. Hence the quantity and character of the ornament in a garden ought to depend on the style of the building to which it belongs; and thus a richly decorated garden would not harmonise with a perfectly plain house; and, on the other hand, a large building loaded with architectural ornament seems to require something more than a few shrubs, planted irregularly around it, which scarcely differ in character from the neighbouring country. It is on this principle that small cottages and houses, which make no pretension to architectural beauty, are much improved by the growth of creepers and other plants upon their walls, which, as it were, makes them a part of the surrounding vegetation. On the other hand, in buildings which, from their imposing size and elaborate execution, have an independent character of their own, creepers usually suggest a notion of discomfort and neglect, a feeling which has no place if the building is not inhabited by man, and which, therefore, is not awakened by the sight of an ancient mouldering ruin overgrown with ivy. (See Price 'On the Picturesque,' vol. i. p. 287, vol. ii. pp. 134, 170, 177, 218; Lord Aberdeen 'On Grecian Architecture,' p. 45.)

The perception of fitness or congruity appears to us to account for the beauty of form in nearly all cases, and occasionally for the beauty of colour: there are, however, other circumstances which contribute to produce or heighten that feeling, or are conditions necessary to its existence. Such, for example, is the beauty of *expression* in the human countenance, when the notion conveyed to the mind is that of benevolence, cheerfulness, tranquillity, innocence, simplicity, or affection. (See Bacon's 'Essay on Beauty.') The distinctness and rapidity with which the eyes express the emotions of the mind contribute very powerfully to their beauty. *Novelty* likewise is, to a certain extent, essential to the perception of beauty; and as the most beautiful object would, by its continual presence, soon pall upon the sight, and produce complete indifference, so objects, whose beauty will not bear close examination, and is only calculated to please for a time, are agreeable merely from their novelty and freshness. This is the case to a great extent with fashions in dress, which are continually changing, and in which the newest fashion often seems the most beautiful, although it may have no other recommendation than its novelty. It does not, however, seem to us satisfactory to explain the beauty of modes of dress by saying, that "while they were in fashion they were the forms and colours which distinguished the rich and the noble, the eminent, the envied, the observed in society; they were the forms and the colours in which all that was beautiful, and admired, and exalted were habitually arrayed. They were associated, therefore, with ideas of opulence, and elegance, and gaiety, and all that is captivating and bewitching in manners, fortune, and situation, and *derived the whole of their beauty from those associations.*" ('Encycl. Britan.,' art. 'Beauty,' Suppl. vol. ii. p. 186.) For, in the first place, there is always a certain regard to utility in all kinds of dress and ornament for the person: colours are selected with reference to the colour of the complexion or hair, different dresses become the young and old, &c.; and those forms are usually chosen which, if not the *most* adapted to the motion of the limbs and the display of the natural beauties, are at least *consistent with them.* (See Hogarth's 'Analysis of Beauty,' c. 6, ad fin.) Caprice or bad taste may sometimes introduce such fashions as hair-powder, pomatum, and hoops, and habit may reconcile the eye to such monstrous disguises; but it seems incredible that any person should maintain that modes of dress are in themselves indifferent, and that the powdered and plastered hair and stiff hoop of an English or French lady of the 18th or middle of the 19th century are intrinsically as beautiful as the loose and flowing locks and graceful drapery of a Grecian statue. New modes of dress are worn, not because they are *beautiful*, but because they are *fashionable.* Ladies not unfrequently lament that the new fashion is ugly and unbecoming, though they abandon the old fashion as being obsolete. Brilliant colours, moreover, are almost universally considered beautiful for dress, especially for female dress; and therefore they are worn by the rich, who can afford a frequent succession of clothes: the poor, who cannot, are consequently forced to clothe themselves in dark and dingy colours, which are not so soon soiled and spoilt. So likewise fine, soft, and smooth textures are not only more convenient, but more beautiful for clothing, as being better fitted to show the form of the body: in this respect the taste of all ages has agreed, from the Romans, who admired the cobweb garments, the *textilis aura*, which they imported from the East, and who bartered gold for an equal weight of silk, down to the modern purchasers of the delicate fabrics of Paisley and Lyons: and hence the rich clothe themselves in fine linen and woollen, in silk, in velvet, and in lace; while the poor, unable to purchase such luxuries, content themselves with coarser and thicker textures. In fact, however, the dress of the rich is not beautiful because it is the dress of the rich, but it is the dress of the rich because it is beautiful: costly furniture is not beautiful because it is costly, but it is costly because it is beautiful. The dress of the poor is not plain because it is the dress of the poor, but it is the dress of the poor because it is plain. In countries where the peasants ornament their dress with taste and fancy, as in some cantons of Switzerland, their dress is thought beautiful; in countries, as in ancient Venice, where the upper orders wore black clothes, black might have been considered a mark of nobility and rank, but could scarcely, even by the natives, have been considered as beautiful: nor in this country does any one think a barrister's or even a judge's wig and gown, a clergyman's surplice, or a bishop's sleeves, as having any title to be called beautiful because they are the dress of distinguished persons or professions.

Variety, likewise, is a condition of the beauty of colour nearly allied to novelty. Combinations of colours, if they are not so mixed as to be confused, and if their tints harmonise well together, are for the most part agreeable to the eye; while large and unbroken masses of an uniform hue, such as long flat walls, wide expanses of sand or water, or green plain, are devoid of beauty. The beauty of the human hair arises, in great measure, from the irregularity of its movements, its flexibility and variety of outline, and the changeability of its tint, as its glossy surface reflects the light in different parts; while a bald head is not only deprived of this ornament, but also seems to be shorn of its fair proportions, and to want something which belongs to its integrity.

The most remarkable exception to the ugliness of uniform colours, it has been said, is the beauty of the blue sky and the blue sea; but the colour is never uniform, in fact, but exquisitely graduated. Even, however, when the sea is most brilliant in its colour, how much do a few white sails, scudding along its surface, add not only to the interest but also to the beauty of the scene!

Some writers have thought that a certain *size* is an essential element of beauty: thus Aristotle, in his 'Poetic,' says, that beauty consists in *magnitude* and *proportion*; and, therefore, a very small or a very large animal would be devoid of beauty, the former because the eye could not *distinguish*, the latter because the eye could not *comprehend* its parts.* This notion of Aristotle's doubtless arose from his predominant love of making the excellence of everything to consist in a mean between two extremes; but in the case which he puts the mean is the beautiful form, because it is the best suited to the nature and wants of the animal. That beauty *generally* does not depend on the size of the object which makes the impression on the sense, is proved by the admiration which we equally bestow on the delicate frame and brilliant plumage of a humming-bird, and on the vast expanse of an Alpine view. Burke, on the other hand, makes *smallness* an essential element of beauty ('Sublime and Beautiful,' part iii. § 13); but the arguments which he adduces are equally untenable, as being founded on a partial view of the subject. Among other considerations he alleges the practice of giving diminutive names to the objects of our affection; but this arises not from any sense of the connection of beauty with smallness of size, but from the incompatibility of the passion of *love* with that of *fear*—that is, so far as fear means an anticipation of evil; for by using diminutive names, expressive of weakness and inferiority, men signify their consciousness that the persons whom they love are things in their power, of which they entertain no apprehension and do not stand in awe.

The feeling of beauty is, moreover, increased, if not awakened, by ancient recollections, which spread a charm over places illustrated by the arts, the learning, and the civil and military glories of former ages. It is, however, necessary to distinguish between the quality of *beauty* and the feelings excited by *interesting* historical associations. There is no doubt that the first time that a scholar beholds Athens or Rome, he is affected far more powerfully and agreeably than a person to whom ancient history is a blank. But these emotions cannot be considered as arising from the perception of beauty. It seems to us quite conceivable that a painter who did not know that Pericles or Socrates were Athenians, or that the Parthenon was the Temple of Minerva, should be as much alive to the *beauty* of the view of Athens as the historian, though his feelings would not be so strongly moved by the sight before his eyes. (See Knight 'On Taste,' part 2, ch. ii. § 70-73.)

* Τὸ γὰρ καλὸν ἐν μεγέθει καὶ τάξει ἐστί, &c., 'Poet,' chap. vii.; and see Twining's translation, note 61, where several passages are cited showing the opinions of the Greeks as to the close connexion of large size and beauty. Our word *handsome*, in like manner, includes an idea of size above the ordinary standard.

This distinction between associations which give an *interest* to an object, which make us *curious* to see it, and those which make it *beautiful*, has not always been sufficiently attended to. Thus Mr. Alison cites Runnymede and the Rubicon as instances of beauty conferred or enhanced by historical associations. (Vol. i. pp. 25, 27.) But beauty never arises from such a source as this. No man would think a plain green field or an ordinary stream more beautiful than any other such field or stream, simply because King John had signed Magna Charta in the one, or Julius Cæsar raised the standard of rebellion on the banks of the other. A sincere Roman Catholic might be led into trains of the tenderest pathos and the loftiest religious enthusiasm by the sight of a fragment of the true cross, but would find no beauty in it. The iron crown of Charlemagne, or the stone on which the Scottish kings were crowned at Scone, would suggest historical recollections of deep interest, but would be devoid of beauty. The same may be said of badges of distinction, as orders, crowns, coronets, mitres, &c.; they may call up ideas of nobility, magnificence, grandeur, courage, or power, and yet they may not be beautiful. No one probably ever found any beauty in the Garter, the Victoria Cross, or the Cross of the Legion of Honour, however lofty or agreeable their associations may be. Feelings of this kind may make the mind susceptible to impressions of beauty, but cannot alone produce it. What can have less pretensions to beauty than a modern fortress, with its bare walls and heavy unornamented masonry? Yet it is inseparably connected with all those ideas of power, grandeur, martial prowess, and courage, to which Mr. Alison in other cases refers the origin of beauty.

Having thus attempted to give a general account of the origin and causes of beauty in outward objects, we shall next consider the *state of mind* which is most favourable to the perception of it.

In the first place it may be remarked that a *certain degree of cultivation* is necessary to the perception of beauty. Savage nations appear to be nearly or quite destitute of any notion of it, in the works both of nature and art, or at least their admiration, as in children, is confined to gaudy and shining trinkets and ornaments of the person. The practice of tattooing, however, is doubtless founded on notions of beauty, more mistaken even than those which led the ladies of Europe to cover their hair with powder and pomatum. In the lower orders of civilised nations the same indifference to beauty may be generally observed, in proportion to their coarseness and ignorance. The early development of the sense of beauty among the Greeks, which is so strikingly shown both in their mythology and poetry, and in their works of art (see 'Philological Museum,' vol. ii. p. 165-166), is a proof of their early culture and of their great superiority, even in a half savage state, to the barbarous nations by which they were surrounded.

Another thing essential to the perception of beauty is *sensibility of mind*, arising from the development of the social affections, and the cultivation of the benevolent feelings. The custom, prevalent in some countries, of planting flowers on graves, and of offering nosegays to the images of saints or of the Virgin, is a mark at once of a feeling of beauty and of sensibility of mind. On the other hand, persons of a sour, phlegmatic, morose, and misanthropic temperament, are little alive to the beauty of outward objects or works of art. It was, doubtless, from a sense of the incompatibility of a feeling for beauty with absence of all social and benevolent sympathies, that Milton represents the Devil as insensible to the beauties of Paradise:—

> "The Fiend
> Saw undelighted all delight, all kind
> Of living creatures, new to sight and strange."

As on the one hand, all the antisocial passions, as anger, jealousy, envy, fear, &c., are inconsistent with the perception of beauty; so the social passions sharpen and facilitate it, as love and pity, which, as Dryden says, "melts the soul to love." Hence *loveliness* in the human race is intimately connected with beauty, as the desire of sex is heightened and stimulated by the beauty of form, colour, and expression; but it is not identical with it, for lovers are often not only blind to the defects of their mistresses, but sometimes even admire them on that very account: whence love is proverbially said to be blind.

A third requisite to the perception of beauty is *serenity* and *cheerfulness of mind*, and the absence of overpowering care or affliction, which engrosses the faculties and prevents them from taking pleasure in the relations of outward objects. This inconsistency is well illustrated by the reflections of Hamlet, when he is oppressed with a sense of the painful task imposed upon him by his father's spirit. (Act ii. sc. 2.) (See Alison 'On Taste,' vol. i. p. 10.)

On the relation of the beauty of outward objects to the beauty of works of art, more will be said under the heads of the several arts. Here it is only necessary to observe, that of the three arts of design, namely, architecture, sculpture, and painting, the two last are purely *representative* arts, while the first alone creates objects which have a *use* beyond the mere gratification of the taste. The beauty of buildings therefore belongs to the class of objects which we have been above examining; while the beauty of pictures and statues, though closely connected with the same range of ideas, yet forms a class apart, and requires the consideration of additional elements peculiar to itself. These are derived in great measure from the capabilities of the respective arts, as dependent on the materials which they work with and the effects which they are thus able to produce. There are many objects

beautiful in nature which cannot be represented with advantage by the painter or sculptor; on the other hand, there are many objects disagreeable in nature which are beautiful in a picture, because a picture is an abstraction, a representation of the colour and outline of an object, without any of those accompanying circumstances which in the reality may cause disgust to the other senses, and thus prevent the mind from enjoying that pleasure which it might otherwise derive through the organ of sight alone. Hence those things in nature which are peculiarly fitted to be subjects for a painter, are properly said to have *picturesque beauty*, as those forms and postures which would appear to most advantage in marble, might, as has been truly remarked, be said to have *sculpturesque beauty*. There are certain general characteristics of these two arts, as that painting best represents expression, whilst sculpture best represents character; that painting embraces a vast variety of subjects, whilst sculpture confines itself almost exclusively to the human figure and some of the nobler animals, which may be here pointed out; but to determine the peculiar provinces of these two arts respectively requires a separate investigation, with reference not to the general subject of beauty, but to the capabilities and advantages of each, and would be materially assisted by a knowledge of those mechanical processes and mysteries of art which the professed sculptor or painter can themselves alone possess.

(On the relation of the beautiful and the sublime, see the article SUBLIMITY; and on the more psychological view of Beauty of recent German philosophers, see ÆSTHETICS.)

BEBIRIC ACID. [BEBIRINE.]

BEBIRINE ($C_{38}H_{21}NO_6$). An alkaloid found by Dr. Rodie in the bark of a tree (the *Nectandra Rodiei*) growing in British Guiana, and used by the inhabitants as a remedy for fever, in the place of quinine. According to Maclagan, the Bebirine of Rodie contains two alkaloids; *bebirine*, possessing the above formula, and *sepirine*, which is a reddish-brown resinous body, that has not been further examined. Bebirine is a white, inodorous, amorphous powder, possessing a strong and persistent bitter taste. It is nearly insoluble in water, but soluble in alcohol and ether. It forms with acids bitter and uncrystallisable salts. Bebirine and sepirine are contained in the bark, in combination with *bebiric acid*, the composition of which is not known.

BEBIRINE, *Medical uses of*. The part used in medicine is the bark. It is derived from the trunk, and comes over in flat heavy pieces from 1 to 2 feet long, from 2 to 6 inches broad, and about 3 or 4 inches thick. The epidermis is brittle, and of a grayish-brown colour. Internally the bark is of a cinnamon-brown colour. The fracture is rough and fibrous. The taste is bitter, astringent, and aromatic. The seeds also contain the bebirine, on which the medicinal properties of the plant depends. The following is Dr. Maclagan's analysis of the two:

	Bark.	Seed.
Bebirine	2·56	2·20
Tannin and resinous matter	2·53	4·04
Soluble matter	4·34	9·40
Starch		53·51
Fibre and albumen	62·92	11·24
Ashes	7·13	0·31
Water	14·07	18·13
Loss	6·45	1·17
	100·00	100·00

The alkaloid bebirine is obtained by decomposing commercial sulphate of bebirine by ammonia; the precipitate is washed with cold water, triturated whilst still moist with moist hydrated oxide of lead, dried in a water-bath and exhausted rectified spirit; an alcoholic solution of bebirine is thus obtained. The alcohol may then be distilled from the bebirine. If this is heated with ether a part will be left undissolved. Dr. Maclagan thought this another alkaloid, and called it sepirine, but he now regards it as bebirine in an oxidised condition.

When bebirine is obtained from its etherial solution, it is a yellow, amorphous, resinous-looking substance, but in the form of powder it is white.

The effect of the Bibiru bark is the same as that of cinchona. It is bitter and tonic, and possesses antiperiodic or febrifugal virtues. The alkaloid possesses the same properties; and from experiments which have hitherto been made, although it is not so powerfully febrifugal as quinine, it does not produce the headache, feverishness, singing in the ears, and other symptoms which are sometimes found to follow the administration of quinine. In intermittent and remittent fevers, in neuralgia, and as a genuine tonic it has been recommended, and especially in those cases where quinine disagrees.

BED OF JUSTICE. This expression (*lit de justice*) literally denoted the seat or throne upon which the king of France was accustomed to sit when personally present in parliaments. Under the ancient monarchy of France, a bed of justice denoted a solemn session of the king in the parliament, for the purpose of registering or promulgating edicts or ordinances. According to the principle of the old French constitution, the authority of the parliament, being derived entirely from the crown, ceased when the king was present; and consequently, all ordinances enrolled at a bed of justice were acts of the royal will, and of more authenticity and effect than decisions of parliament. The last bed of justice was assembled by Louis XVI. at Versailles, on the

20th of September, 1787, at the commencement of the French revolution, and was intended to enforce upon the parliament of Paris the adoption of the obnoxious taxes, which had been previously proposed by Calonne at the Assembly of Notables. But when the Duke of Orleans inquired of the king whether it was to be considered a *lit de justice* or a deliberative consultation, the king replied that it was a royal sitting. ('Thiers,' vol. i.) The edicts, however, were recorded, though there was much opposition.

BEDCHAMBER, LORDS OF THE, are officers of the royal household, under the groom of the stole. The number of lords is twelve, who wait a week each in turn; queens regnant are attended by a like number of ladies of the bedchamber, under a mistress of the robes. The groom of the stole does not take his turn of duty, but attends on all state occasions. There are thirteen grooms of the bedchamber who wait likewise in turn. All the appointments are in the royal nomination, and salaries are provided for all of them.

The title of lords of the bedchamber appears to have been adopted after the accession of the House of Hanover. They are first mentioned by that title in Chamberlayne's 'State of England,' for 1718.

BEDE-HOUSE, a term used for an alms-house. Hence bede-man, or beid-man, a person who resides in a bede-house, or is supported from the funds appropriated for this purpose. In the Court of Exchequer in Scotland, this term is used to denote that class of paupers who enjoy the royal bounty.

BEDESMAN, or BEEDMAN, from bede, a prayer, and that from the Anglo-Saxon biđ-an, to pray, was a common mode of signature in the time of Henry VIII. at the end of letters; as of a prayer-man, or one who prayed for another. Sir Thomas More, in writing to Cardinal Wolsey, ordinarily styles himself "Your humble orator and most bounden beedman, Thomas More." (See Ellis's 'Orig. Letters illustr. of English Hist.' first ser. vol. i.) Margaret Bryan, the governess of the Lady Elizabeth, writing to Lord Cromwell, signs herself in the same manner, "Your dayly *bede-woman*." (*Ibid.* second ser. vol. ii.)

"Great men of old," says Mr. Knight in his 'Pictorial Shakspere' illustrations of 'Two Gentlemen of Verona,' "did not wholly depend upon the efficacy of the prayers for their welfare which proceeded from the expectation or gratitude of their suitors. They had regularly appointed bedesmen, who were paid to weary Heaven with their supplications. It is to this practice that Shakspere alludes, in the speech of Scroop to Richard II.:

> "Thy very bedesmen learn to bend their bows
> Of double fatal yew against thy state."

Colleges of bedesmen were also founded; and in Scotland the institution, in a modified way, continued, till a comparatively recent period. Scott's Edie Ochiltree, in 'The Antiquary,' was one of the king's bedesmen, who were expected "to pray for the royal welfare and that of the state."

BEDLAM, a corruption of Bethlehem, the name of a religious house in London, which, subsequently to the dissolution of monasteries, was converted into an hospital for lunatics, but still retained its former appellation. It was granted by Henry VIII., in 1547, with all its revenues, to the mayor, commonalty, and citizens of London, from which time only it became an hospital for the care of lunatics. In the infant state of this charity no other provision was made for the unfortunate patients, besides confinement and medical relief; it was left for the judicious benevolence of succeeding times to improve the good work, and to supply the subsistence and care which has restored so many distracted objects to their families and to society. There is no account of donations received for this institution before the year 1632. A New Hospital of Bethlehem, as it was then termed, was begun to be built in April, 1675, upon a plot of ground near London Wall; and this has since given way to a fitter building for its purpose, erected in 1814, upon a distant, but more commodious spot, but since greatly enlarged and improved. The Hospital of St. Mary Bethlem now stands upon the other side of the Thames, in the parish of Lambeth. [Lunatic Asylum.]

BEDLAM BEGGARS was the ancient name for such patients of the Hospital of Bethlehem, after it became a lunatic asylum, as, being partially cured, were allowed to go at large; and also for impostors who personated the character. Edgar, in 'King Lear,' act ii. scene iii., when assuming the character of Poor Tom, says—

> "The country gives me proof and precedent
> Of *bedlam beggars*, who, with roaring voices,
> Strike in their numb'd and mortified bare arms
> Pins, wooden pricks, nails, sprigs of rosemary," &c.

Aubrey, in his 'Remains of Gentilisme,' an unpublished work, preserved among the Lansdown manuscripts in the British Museum, part iii. fol. 234 b., tells us, "Till the breaking out of the civil wars, Tom o' Bedlams did travel about the country. They had been poor distracted men, that had been put into Bedlam, where, recovering some soberness, they were licentiated to go a-begging; *i. e.*, they had on their left arm an armilla, an iron ring for the arm, about four inches long, as printed in some works. They could not get it off; they wore about their necks a great horn of an ox in a string or bawdry (baldrick), which, when they came to a house, they did wind, and they did put the drink given to them into the horn, wherein they put a stopple. Since the wars, I do not remember to have seen any one of them." The ox-horn for holding their drink explains Edgar's speech ('Lear,' act iii. sc. 6), "Poor Tom, thy horn is dry."

BEDSTEAD. Bedsteads for domestic use, of whatever form, are most commonly made of wood, and of somewhat massive construction; but the much smaller space occupied by light bedsteads of iron and brass, their consequent superiority in favouring that free ventilation which is so important to health, and the great advantage which they possess in not harbouring vermin, have led to their extensive introduction of late years in the dormitories of barracks, hospitals, and other public establishments; while their elegant lightness, and the facility with which they may be taken to pieces, packed in a small compass, and put together in a short time, recommend them strongly for camp and travelling use, as well as, in many cases, for articles of household furniture.

Another class of bedsteads which claims notice, comprises those ingenious contrivances which have been devised for the comfort of invalids, and to facilitate the necessary surgical operations upon patients with fractured limbs, or such as have wounds requiring frequent dressing and careful shielding from the injuries incidental to even the most careful removal of the body. By means of such inventions—several of which, having been proved by experience to be efficient, have been rewarded by the Society of Arts—the position of a bed-ridden patient may be varied in many ways, with little or no exertion to himself, and the offices of the attendant and the surgeon may be performed with the greatest possible facility. Even these, however, have failed in one important point; for however perfect their mechanical arrangements may be, they cannot prevent the distressing consequences which arise from the unequal pressure of a body reduced to a state of extreme debility upon a bed which, however soft, cannot supply a uniform support to every portion of its surface. In many cases where the primary disease or injury has been insufficient to destroy life, mortification and death have ensued from this unequal pressure, notwithstanding the utmost care and the use of air-cushions and down-pillows to mitigate the evil. A painful case of this character having come under the notice of Dr. Arnott, led him to the invention of the *hydrostatic* or *water-bed*. This consists of a trough lined with thin sheets of metal, and partially filled with water, upon the surface of which floats a sheet of waterproof India-rubber cloth, of sufficient size to completely line the trough when empty, and secured to its upper edge in such a way as to prevent the escape of the water by capillary action. Upon this sheet is laid an ordinary soft feather-bed or mattress, which, floating on the yielding surface of the water, affords a support to the patient comparable only to that afforded by the water of a bath. Every point of the uneven surface of the body having, as it were, its separate column of support, the pressure is so equally distributed as to afford the patient comfortable rest, and effectually to prevent the formation of sores upon the most prominent points. The depth to which the body will sink in such a bed may be regulated by the thickness and buoyancy of the mattress; and any unusual position may be obtained by placing light and bulky cushions or folded blankets under such parts of the body as it may be desired to elevate, just as the position of a body floating in water may be affected by the use of buoys. The mass of water prevents the approach of cold air from beneath, and also, by its non-conducting properties, does not allow of the dispersion of heat downwards, so that, contrary to what might, at first sight, be expected, the hydrostatic bed is a warm one; but as the impermeability of the India-rubber cloth impedes the escape of perspiration, care should be taken, when the patient is unable to leave the bed daily, either to lay a waterproof cloth above the mattress to receive the moisture which would, without it, descend through the mattress, and becoming condensed on the floating sheet below it, would render the bed damp and unwholesome; to lay a blanket, which should be frequently changed, to collect the perspiration which descends from the bed; or to place a layer of small pieces of cork, the interstices of which may afford a degree of ventilation between the mattress and the floating sheet. The perfect adaptability of the surface of such a bed to whatever may be laid upon it, allows the dressing of wounds, the application of poultices, and the performance of other offices of the sick chamber, without disturbing the patient. This, like many other admirable contrivances, Dr. Arnott presented freely for the use of the public without retaining any patent right for himself.

Dr. Ridge's invalid bedstead is an ingenious contrivance, by which a person may be removed from bed with singular ease. There are, in fact, two beds one upon another, the uppermost of which can be lifted and removed by turning a handle. This upper bed, which is little more than a ticking stretched over an iron frame-work, is hinged in three parts, so that it may be made to assume any required position, from that of a horizontal bed to that of an easy-chair; so that it may be said the invalid may be taken from his bed without ever leaving it.

The Great Exhibition of 1851 presented, among others, two bedsteads which were types of two distinct classes. One was the Austrian bedstead, admirable for the extreme beauty of its carving. The other was the "state bed" by Messrs. Faudel and Phillips, one of the most elaborate specimens of modern needle-work; thirty needle-women were employed ten months in embroidering it; and the wool and silk threads employed were dyed in seven hundred different tints.

Mr. Hancock's *bed-chair* is another variety of bedstead. It consists of an air-tight India-rubber bag, so formed as to constitute a convenient bed or cushion when laid down horizontally and inflated with air; while it may be made into a sofa-chair or reclining-bed, by inflating one half of it through a separate aperture, and raising that half to any desired angle by means of suspending bands.

Another novelty, registered by Mr. Perkes in 1850, is a light iron frame-work, capable of being quickly made to assume any one of the four forms of a bed, a couch, a settee, or a crib. Like many similar contrivances, there is a light but strong cast-iron frame, the hinges and other parts of which admit of many different modes of adjustment. [AIR-CUSHION.]

BEECH; ECONOMICAL USES. The common beech, known in America as the *white* beech, is the most useful species of this valuable tree. The timber is hard, and is employed for a great variety of purposes. It is used for the keels and side-planking of ships; for ringing mill-wheels; for making piles, weirs, sluices, flood-gates, and other constructions exposed to the action of water; for cogs of wooden wheels; for making bedsteads and chairs; for panels of carriages; for various articles in joinery, cabinet-making, and turnery; for numberless small articles of household furniture; for railway-sleepers; for barn-floors; for herring-barrels; for wooden shovels and peels; for wooden screws and sieves. In Germany beech-wood is used for many of the purposes above named, and also for gun-carriages, wheel-felloes, bowls, porringers, salt-boxes, spindles, rollers, spinning-wheels, pestles, presses, bellows, and numerous other articles; while, sawn into thin boards, it is used for boxes, packing-cases, sword-scabbards, and even the boards of books (instead of millboard). In France, besides other purposes, beech is used for gun-stocks, plough-socks, cricket-bats, cheap knife-handles, and cheap *sabots*, or wooden shoes.

Beech is used to an enormous extent in France and Germany for fuel. The bark is used in tanning. The dried leaves are said to form an excellent substitute for feathers in beds, and to be largely employed in such a way in some districts. The dried catkins of the leaves are used to stuff cushions. The mast, or fruit, is eaten by many animals; and from this fruit an oil useful for lamps and for cooking is obtained. A *Beech-Oil Company* was one of the most noted commercial speculations of Queen's Anne's reign, at a time when joint-stock undertakings were but ill understood.

BEEF-EATER, a jocular appellation, as it is now used, for the yeomen of the guard; though it seems probable that the name of *buffetiers* was formerly assigned to that portion of the yeomen of the guard who from time to time waited at table at great solemnities, and were ranged near the buffets. (See 'Antiq. Repert.,' edit. 1808, vol. ii. p. 398.) As yeomen of the guard, they were constituted by Henry VII., and they have continued as a royal institution to the present day, and with nearly the same costume as when first established, although in 1858 some modification was introduced into the ordinary habits of those who are stationed at the Tower; but the old costume is still worn on occasions of ceremony.

BEELZEBUB. [BAAL.]

BEER. The distinctions between different kinds of malt liquors are partially noticed under ALE, and will be found further elucidated under BREWING.

BEER-MACHINE, or BEER-ENGINE. In the ordinary beer-machine, each handle has a single action—that is, draws from one cask only; but in many respects it would be useful if two pumps could be worked at once by the same handle. From the rapid fluctuations which malt liquor undergoes in quality, owing to changes in the weather, it is frequently necessary for the retailer to mix old and new beer together, in order to maintain a uniform quality. This is done either by drawing from two butts, by two pumps and two handles, or by mixing beer of two ages in the same butt, by which a liability to a new fermentation is incurred. To obviate these inconveniences was the purpose of Ernest's beer-engines, patented a few years ago. The arrangement of this machine is very ingenious. One handle works the levers, rods, and pistons of two pumps, which may be connected with the beer in two butts. In the usual perpendicular position of the handle it works both pumps at once; but if drawn a little on one side, by a slight movement of the hand, it works one pump only—either one of the two, at pleasure. It is optional with the drawer whether to work one or the other pump, or both, and whether to draw equally or unequally from both.

BEES'-WAX. This important substance constitutes a secretion which is expelled through the interstices of the ventral plates of the honey-bee, and is employed by that insect in the construction of its cells. Bees'-wax is obtained from the expressed honeycomb by agitating the latter with boiling water so as to dissolve out the last portions of honey and other impurities. After allowing the mixture to stand at rest, the wax forms a layer on the surface, whence, on cooling, it may be removed as a solid cake. It is once more fused alone, and being then cast in moulds, forms *yellow* or *virgin wax*. *White*, or *bleached* wax, is obtained from the foregoing, by reducing it to thin strips and exposing the latter to the sun's rays for several days. It may also be bleached, according to Solly, by melting and agitating it with a small quantity of sulphuric acid, diluted with two parts of water to which some fragments of nitrate of soda are added. The bleaching process does not alter the chief constituents of the wax; the colouring matter only appears to be oxidised and bleached.

Bees'-wax fuses at 145° Fahr.; it is completely insoluble in water, but easily soluble in essential and fat oils. We are indebted chiefly to Professor Brodie for an insight into the chemical constituents of bees'-wax. It is composed of two principal bodies, formerly termed *cerine* and *myricine*. The first is soluble in alcohol, and has been proved by Brodie to be a peculiar acid, the *cerotic acid* ($C_{54}H_{53}O_3$, HO), homologous with acetic acid, crystallising in small grains and fusing at 172° Fahr. It is white, brittle, and volatile at a high temperature, and constitutes 22 per cent. of Surrey wax. According to the same chemist, myricine is an ethereal salt, consisting of palmitic acid united with the oxide of an organic radical, *myricyl* ($C_{60}H_{61}$). The formula of *palmitate of myricyl* (myricine) is $C_{32}H_{31}O_3$, $C_{60}H_{61}O$. Palmitate of myricyl is insoluble in boiling alcohol, fusible at 161°, and possesses a slight odour of wax. Treated with alcoholic solution of potash, it gives palmitate of potash, and *myricylic alcohol* ($C_{60}H_{61}O$, HO). [ALCOHOLS.] By destructive distillation palmitate of myricyl gives an homologue of olefiant gas,—*melene* ($C_{60}H_{60}$).

Bees'-wax is used in the manufacture of candles, and for modelling objects of art. It is also employed in the construction of anatomical models.

BEET, a plant of the genus *Beta*, in the natural order *Chenopodeæ*.

There are two distinct species of beet commonly cultivated, each containing several varieties, the one producing succulent leaves only, the other the *Vulgaris*, distinguished by its large fleshy root. The former is chiefly cultivated in gardens as a culinary vegetable, and forms one of the principal vegetables used by agricultural labourers and small occupiers of land in many parts of Germany, France, and Switzerland. A variety known by the name of Swiss *chard* produces numerous large succulent leaves, which have a very solid rib running along the middle. The leafy part being stripped off and boiled, is used as a substitute for greens and spinach, and the rib and stalk are dressed like asparagus or scorzonera; they have a pleasant sweet taste, and are more wholesome than the cabbage tribe. In a good soil the produce is very abundant, and if cultivated on a large scale in the field, this species of beet would prove a valuable addition to the plants raised for cattle. By cultivating it in rows, and frequently hoeing and stirring the intervals, it would be an excellent substitute for a fallow on good light loams.

All cattle are very fond of the leaves of this beet, which add much to the milk of cows without giving it that bad taste which is unavoidable when they are fed with turnips or cabbages, and which is chiefly owing to the greater rapidity with which the latter undergo the putrefactive fermentation. If sown in May in drills two feet wide, and thinned out to the distance of a foot from plant to plant in the rows, they will produce an abundance of leaves, which may be gathered in August and September, and will grow again rapidly, provided a bunch of the centre leaves be left on each plant. They do not sensibly exhaust the soil. These leaves, when boiled or steamed with bran, cut chaff, or refuse grain, are an excellent food for pigs, or bullocks put up to fatten.

The second species, the *Vulgaris*, or beet-root, has been long cultivated in gardens; especially that variety called the red beet, which, when boiled and sliced, makes such an excellent addition to winter salad. It is a native of the south of Europe, and hence all the varieties are tender, and destroyed by frost when in their young state. It thrives best in a rich, light, dry soil, and, from the length of its tap-root, requires a considerable depth. The white beet is an excellent root, and is preferred by many to the larger and more common intermediate varieties. It has been lately in great repute in France and Belgium for the manufacture of sugar. It is not commonly cultivated in our gardens, and we only notice it as being, with the red beet, the parent of those varieties which have been introduced into field culture.

The common field-beet for cattle, which has been long known in Germany, was introduced into England at the latter end of the last century; and its introduction is generally attributed to the late Dr. Lettsom, a physician of great reputation, and one of the Society of Friends. The German name is *mangold wurzel*, or *mangold* root, but it is commonly pronounced *mangel wurzel*, which means *scarcity* root; and by a strange translation it is called in French *racine d'abondance*, or root of *plenty*, as well as *racine de disette*, or root of *scarcity*. The name of *field-beet* is much more appropriate.

The improved varieties of this beet, which grow to a very large size in good soil, have a red orange skin, and when cut through appears veined with red or yellow, in concentric circles. The principal part of the root, which is either long or round in shape, rises often a foot and more above the ground, and the leaves, which are large and succulent, spring from the crown of the root. There is a limit, however, beyond which the root does not improve in quality as it increases, and the roots of a moderate size contain more saccharine and nutritive matter in the same bulk than the larger. This is particularly the case with those varieties from which sugar is extracted. The soil best adapted for the beet-root is a good loam, naturally rich, or made so by repeated manuring. The manure should be well incorporated with the soil, and what is added for this crop should be well rotted and ploughed in deep. The application of liquid manure during the growth of the plant greatly

increases the roots; but it is also said to make them more watery, and for the sugar beet it is not recommended. The seed, which should be chosen from the most perfect plants, is sown in April or May: if sown sooner, there is some danger from the frosty nights which often occur about the beginning of that month; or if the spring is warm and genial, it gets too forward, and instead of increasing in the root, it shoots up a seed-stalk, and the root becomes comparatively useless. If it is sown later than May, it never arrives at a full size before the approach of winter: hence the last week in April or first in May is the best time in our climate. It is found by experience that those plants of beet which grow from seed sown where they are to remain have larger roots, in general, than those which are transplanted; the seed is therefore usually drilled, or dibbled, in rows about thirty inches distant; the seeds are put in less than an inch deep, and when they are dibbled, the holes are about 15 or 18 inches asunder, and two or three seeds are put in a hole. After they come up and are out of danger of frost or insects, they are thinned out, so as to leave the plants at that interval apart. Where the plants have failed, the intervals are filled up by transplanting some of those which are superfluous in other parts: in doing this it is essential that the fibres of the roots be not torn off in pulling up the plant; and if they are taken up carefully with some of the mould adhering to the roots, it will well repay the additional trouble. If the ground is well prepared, there is little fear of the plants not coming up, or of their being destroyed by the fly, as is too often the case with turnips. A sprinkling of liquid manure along the rows, about the time that the plants first appear above ground, will in general secure an abundance of them; and this may be done with much less trouble than would be imagined, by those who have never practised it. It requires only a water-cart, with a large cask and two leathern hose, kept at a proper distance from each other by a stick between them, so that they may pour the liquid manure over two rows at once. If the field be not above a mile from the tank, a man and horse will water two acres in a day, and if the distance is half a mile, four acres; the expense will be amply repaid in the crop.* Putting the seed in with liquid manure is now not an uncommon practice; and a liquid manure drill, invented by Mr. Chandler of Aldbourne, near Hungerford, is largely used for that purpose; and even where it is not the practice to sow liquid manure with the seed, it is well to moisten the seed for a day or two before sowing in order to ensure early germination.

On a very large scale the practice of watering during the early growth of the plant may not be so practicable; but wherever a field of beet is near the home-stall, the evident advantage of it will soon remove any objection arising from trouble or expense. When the plants are three inches above ground, they may be thinned out, the intervals between the rows may be stirred with the plough, grubber, or horse-hoe, and the intervals from plant to plant in the row with the hand-hoe. The ground cannot be kept too fine and open, provided the soil be not extremely porous. It is a common practice to throw the earth from the rows against the roots; but the most experienced cultivators do not approve of the method; on the contrary, they recommend drawing the earth from the plants, or at least laying the whole ground level. Where the soil is naturally rich and deep, the drills may be made on the level ground; but if the soil is shallow, or the subsoil of a barren nature, it is best to raise small ridges, as is done for turnips on the Northumberland plan, and bury the dung under them, by which means the roots have more room to strike downwards. As soon as the outer leaves begin to droop, they may be gathered and given to cattle, but as the roots will not increase except by the aid of the leaves, they should not be stripped until they are on the point of withering. This practice of gathering the leaves is strongly recommended by some, and they assert that the root does not suffer in the least, although the leaves are reproduced; but here we would give this caution, founded on experience and observation. The drooping leaves, if not gathered, will decay and fall off; they have performed their office, and therefore to gather them before they wither is a real economy: but to strip off fresh and growing leaves must injure the plant, and the juices required to replace them are so much taken from the growth of the roots. When fodder is very scarce this may be a sacrifice worth making, but if the object is to reserve the roots for winter food, the leaves should remain on the plant as long as they look fresh and growing, until near the time of taking up the whole crop: the top may then be cut off an inch above the crown of the root, and will be excellent food for the cows and pigs.

The roots are generally taken up and stored for winter, some time before there is any danger of considerable frost. They are stripped of their leaves and thrown into carts, without their roots being cut, or much care taken to clean them, and thrown into heaps, which if large should have such means of ventilation, as a faggot thrust in to the midst of them at top will afford. The heaps are then covered with straw and earth and left for the winter. Or the roots may be piled between hurdles, placed six feet apart from one another, the interval

* If the water-cart contains 100 gallons, it will water one-third of an acre in rows of three feet distance; the horse will go over one mile and a half in an ordinary shaped field to water an acre, to which must be added twice the distance from the tank, taken three times. This makes in all $1\frac{1}{2} + 6$, or $7\frac{1}{2}$ miles for each acre, when the distance is one mile.

being filled with them, and piled up and thatched over, a faggot being inserted every eight feet. And where several such heaps are placed along side at one or two feet apart, the bushy eaves of a rough thatching interlocking over the interval affords sufficient protection from the weather—the intervals themselves should be also filled with straw, and the whole of the heaps fenced round and protected in a similar manner. In the case of earthing over the heaps, the roots should be put in dry, and some time allowed for a slight fermentation, and the steam produced allowed to escape before the heap is finally covered in, and they will come out quite fresh and juicy till late in the spring; but if the proper precautions are neglected, they will often rot or become musty, and then the cattle will not readily eat them. There are few crops so valuable for winter food for cattle as the beet; Swedish turnips, or ruta baga, exceed them in the quantity of nourishment, weight for weight, but on good light soils the produce of the beet per acre is much greater. On old pasture ground trenched up enormous crops of mangel wurzel have been raised. When the Regents Park was forming, a part which had been trenched was sown very thick with mangel wurzel seed, and such was the produce, that it was sold by auction, in lots, to the cow-keepers in the neighbourhood, at the rate of 80*l.* per acre.

For bullocks also they are excellent; for horses Swedish turnips are preferable. The proportional value of hay, potatoes, Swedish turnips, and beet in feeding cattle, according to Einhof, whose statements Thaer has found to agree with his experiments, is as follows:—18 tons of mangel wurzel are equal to 15 tons of ruta baga, or $7\frac{1}{2}$ tons of potatoes, or $3\frac{3}{4}$ tons of good meadow hay, each quantity containing the same nourishment: but the roots may be grown upon less than an acre, whereas it will take two or three acres of good meadow-land to produce the equivalent quantity of hay; and of all these root crops the least exhausting for the land is the beet. Professor Johnston gives their composition as follows, taking a rough average of several varieties:—

Water	85· per cent.
Gum	0·5 „
Sugar	10· „
Nitrogenous ingredients	0·4 „
Fibre, &c.	4· „
	99·9

Dr. Völcker states in Morton's 'Cyclopædia' that the

Flesh-forming ingredients amount to	1·8 per cent.
The heat-giving ingredients to	11·2 „
The ash, to about	1· „
And the water to	86·0

The ingredients of this ash are in such proportion, that each ton per acre removes from the soil, according to Professor Way, the following quantities of

	In the Bulb. lbs.	In the Leaf. lbs.
Potash	4·99	7·86
Soda	3·02	2·52
Lime	0·41	3·31
Magnesia	0·43	3·27
Oxide of iron	0·12	0·52
Phosphoric acid	0·66	1·94
Sulphuric acid	0·65	2·20
Chloride of Sodium	5·29	12·82
Silica	0·54	0·76
	16·11	35·20

The noticeable feature in these figures is the quantity of chloride of sodium present, and it is a fact borne out by large experience, that this common salt is a useful application along with the manure to the mangold wurzel crop.

The white beet has been chiefly cultivated for the extraction of sugar from its juice. It is smaller than the mangold wurzel, and more compact, and appears in its texture to be more like the Swedish turnip. We have given it to cattle, and are satisfied with the result; but we have not made sufficiently accurate experiments to decide which sort is the most advantageous. It will probably be found that the nature of the soil will make the scale turn in favour of the one or the other; but for the manufacture of sugar, the smaller beet, of which the roots weigh only one or two pounds, are preferred by Chaptal, who, besides being a celebrated chemist, was also a practical agriculturist, and a manufacturer of sugar from beet-root.

This manufacture sprung up in France in consequence of Bonaparte's scheme for destroying the colonial prosperity of Great Britain by excluding British colonial produce. It having been found that from the juice of the beet-root a crystallisable sugar could be obtained, he encouraged the establishment of the manufacture by every advantage which monopoly and premiums could give it. Colonial sugar was at the enormous price of four and five francs a pound, and the use of it was become so habitual, that no Frenchman could do without it. Several large manufactories of sugar from beet-root were established, some of which only served as pretexts for selling smuggled colonial sugar as the produce of their own works. Count Chaptal, however,

established one on his own farm, raising the beet-root, as well as extracting the sugar. We here give a brief account of the process, taken chiefly from his own publications, especially the work entitled 'La Chimie appliquée à l'Agriculture,' 2 vols. 8vo, Paris, 1829. The first operation is to clean the roots: some effect this by washing, but Chaptal prefers scraping and paring them with a knife, although by this means one-sixth part of the root is wasted, as the scrapings mixed with earth cannot be safely given to cattle, and even the pigs eat but little of it; but it adds to the manure, and is therefore not altogether lost. Six tons of beet-root are thus reduced to five, which are next to be rasped and reduced to a pulp. This is done by a machine consisting of a cylinder of tinned iron, two feet in diameter, and eighteen inches in the axis, on which it is turned by machinery. On the circumference of this cylinder are fixed, by means of screws, ninety narrow plates of iron, rising three-fourths of an inch from the surface and parallel to the axis, at equal distances all round; the outer or projecting edges of these plates are cut into teeth like a saw; a slanting box is fixed to the frame on which the axis of the cylinder turns, so that the roots may be pressed against these plates. The cylinder is made to revolve rapidly, and the roots are thus scraped, the pulp falling into a vessel, lined with lead, placed below. When two such cylinders are made to revolve 400 times in a minute by a sufficient power, whether water, wind, or horses, two and a half tons of roots are ground down in two hours. It is necessary that this operation should proceed rapidly, or else the pulp acquires a dark colour, and an incipient fermentation takes place, which greatly injures the future results. As the pulp is ground it is put into strong canvas bags, and placed under a powerful press to squeeze out the juice. The residue is stirred, and subjected to a second and third pressure, if necessary, till every particle of juice is extracted. As the liquor is pressed out, it runs into a copper, until it is two-thirds filled. The strength is ascertained by an instrument similar to the saccharometer used by brewers, called the *pèse-liqueur* of Beaumé,* which shows the specific gravity of the liquid. The fire is now lighted, and by the time the copper is full the heat should be raised to 178° of Fahrenheit's thermometer (65° of Réaumur), but no higher.

In the mean time a mixture of lime and water has been prepared by gradually pouring as much water upon 10lb. of quick lime as will make the mixture of the consistency of cream. This is poured into the copper when the heat is steadily at 178°, and is well mixed with the juice by stirring it. The heat is then increased till the mixture boils, when a thick and glutinous scum rises to the surface. As soon as clear bubbles rise through this scum, the fire is suddenly put out by water poured on it or by a proper damper. The scum hardens as it cools, and the sediment being deposited the liquor becomes clear and of a light straw colour. The scum is then carefully taken off with a skimmer having holes in it, and is put into a vessel till such time as the liquor remaining in it can be pressed out. A cock is now opened about five inches above the bottom of the boiler, and all the clear liquor is drawn off. Another cock lower down lets out the remainder until it begins to appear cloudy; what still remains is afterwards boiled again with what is extracted by pressure from the scum. The clear liquor is now subjected to evaporation in another boiler which is wide and shallow. The bottom is but slightly covered with the juice at first, and it boils rapidly. As the water evaporates, fresh juice is let in. When a certain degree of inspissation or thickening has taken place, so as to show five or six degrees of strength on the *pèse-liqueur*, animal charcoal is gradually added till the liquor arrives at 20°. One hundred weight of charcoal is required for the juice of 2½ tons of beet, which is now reduced to about 400 gallons. The evaporation by boiling continues till the saccharometer marks 25° and a regular syrup is obtained. This is now strained through a linen bag, and the liquor is kept flowing by means of steam or hot air, and assisted by pressure. In two or three hours all the clear syrup will have run through.

There are many nice circumstances to be attended to, which can only be learned by experience, and an outline of the process is all that we undertake to give.

The syrup thus prepared is again boiled and skimmed until it is sufficiently concentrated, which is known in the following manner. The skimmer is dipped into the syrup and drawn out; some of the thick syrup which adheres to it is taken between the thumb and fore-finger and held there till the heat is reduced to that of the skin; the finger and thumb are separated, and if the syrup is of a proper strength, a thread will be drawn out, which snaps and has the transparency of horn or rather barley-sugar: this is called the *proof*. The fire is then put out and the syrup is carried to the cooler, which is a vessel capable of containing all the syrup produced by four operations or boilings. Here the sugar is to crystallise: as soon as this commences the whole is well mixed and stirred, and before it becomes too stiff, earthen moulds, of the well-known sugar-loaf shape, and of the size called *great bastards*, are filled with the crytallising mass, of which a little at a time is poured into each. When they are full, they are carried to the coolest place on the premises. As the crystallisation goes on, the crust formed on the top is repeatedly broken, and the whole is stirred

* The *pèse-liqueur* of Beaume here referred to is an hydrometer, of which 0° corresponds to 1·000, the specific gravity of pure water at 55° of Fahrenheit; and 25° to about 1·215.

till the crystals are collected in the centre; it is then allowed to go on without further disturbance. In three days it is so far advanced, that the pegs which were put into the holes at the point of the moulds may be taken out and the molasses allowed to run out. In a week this is mostly run off. White syrup is now poured on the top of the moulds, which filters through the mass and carries part of the colouring matter with it. The process that follows is exactly that in common use in refining West India sugars.

Although most of the operations are nearly the same as those by which the juice of the sugar-cane is prepared for use, much greater skill and nicety are required in rendering the juice of the beet-root crystallisable on account of its greater rawness, and the smaller quantity of sugar that it contains. But when the sugar is refined, it is impossible for the most experienced judge to distinguish it from the other, either by the taste or appearance; and from this arose the facility with which smuggled colonial sugar was sold in France, under the name of sugar from beet-root. Five tons of clean roots produce about 4½ cwt. of coarse sugar, which give about 160 lbs. of double-refined sugar, and 60 lbs. of inferior lump-sugar. The rest is molasses from which a good spirit is distilled. The dry residue of the roots, after expressing the juice, consists chiefly of fibre and mucilage, and amounts to about one-fourth of the weight of the clean roots used. It contains all the nutritive part of the root, with the exception of 4½ per cent. of sugar, which has been extracted from the juice, the rest being water. Two pounds of this dry residue and half a pound of good hay, are considered as sufficient food for a moderate-sized sheep for a day, and will keep it in good condition; and cattle in proportion.

As the expense of this manufacture greatly exceeds the value of the sugar produced, according to the price of colonial sugar, it is only by the artificial encouragement of a monopoly and premiums that it can ever be carried on to advantage. The process is one of mere curiosity as long as sugar from the sugar-cane can be obtained, and the import duties laid upon it are not so excessive as to amount to a prohibition; and in this case it is almost impossible to prevent its clandestine introduction.

By allowing the juice of the beet-root to undergo the vinous fermentation and by distilling it, a more profitable result will be obtained in a very good spirit. A kind of beer may also be made of it, which is said to be pleasant in warm weather and wholesome.

Another mode of making sugar from beet root, practised in some parts of Germany, is as follows, and is said to make better sugar than the other process. The roots having been washed are sliced lengthways, strung on packthread and hung up to dry. The object of this is to let the watery juice evaporate, and the sweet juice, being concentrated, is taking up by macerating the dry slices in water. It is managed so that all the juice shall be extracted by a very small quantity of water, which saves much of the trouble of evaporation. Professor Lampadius obtained from 110 lbs. of roots 4 lbs. of well-grained white powder-sugar, and the residuum afforded 7 pints of spirit. Achard says that about a ton of roots produced 100 lbs. of raw sugar, which gave 55 lbs. of refined sugar, and 25 lbs. of treacle. This result is not very different from that of Chaptal.

The production of a spirit by fermentation and distillation from the juices of the beet is now a very extensive manufacture on the continent, and it is sought to introduce it into this country. The question on which its profitableness here must hinge is this: are beet-roots grown in an English climate as full of saccharine juice as those grown under the warm sun of France? We imagine not; and it is extremely doubtful if any more profitable way of using the land set apart for this crop exists in this country than that of sowing seed of the largest sorts for the growth of food for the production of milk and beef and mutton.

Meanwhile we add the following paragraph descriptive of one of the processes adopted, though Champonnois' and other patent methods of extracting the spirit exist.

Leplay's system of distilling from beet-root consists in fermenting the juice, while still in slices, of the root, and in passing over heated steam, through vessels full of these slices, after the fermentation is completed. Mr. Weeks, of Bolney Lodge, Sussex, states in the 'Times' that, during the last season nearly 5000 tons have been distilled in this country on this plan, yielding 40,000 gallons of proof spirit. The refuse is nutritive, and he says that his experience of the steamed roots after distillation is conclusive on this point. "Some Cull South-down lambs I purchased on July 5th last, at 12*s.* 6*d.* each, and sold last week, fatted almost entirely on the steamed roots, at 38*s.* each, after taking a better fleece of wool than usual. Nor could I have fatted them so well on any other produce. And in so steaming the roots is it not better to catch the steam and condense it into spirit than let it go up the chimney to evaporate in the air?" It is only right to add that the subject is properly one for experiment, the view thus expressed not being so self-evident as it is here implied to be. The steam carries off that which in the original root contributes to its nutritive character, the fermentation having conferred an evaporable character upon it; and French grown roots, grown under a somewhat different climate, contain probably more of this spirit-yielding portion of the root than our own. The recently published official report on the experiments of the past year declares them to have hitherto failed to yield a profitable spirit.

BEG, also pronounced BEY, is a Turkish word which signifies "prince, lord, or chief," and in the Ottoman empire is rather vaguely used as a title of governors and other high officers of the state. It is also frequently subjoined to proper names, to distinguish persons of high rank generally.

BEGGAR. [PAUPERISM AND POOR-LAWS.]

BEGLERBEG, a compound word, which properly signifies "chief of chiefs," and the title of the governor-generals of the provinces. They stood next in rank to the vizir, and had under their jurisdiction many *sanjaks*, or districts, with their begs, agas, &c. One of their external distinctions was that the sultan of Constantinople always bestowed on them three ensigns, named in Turkish *tugh*, which consisted of staves trimmed with the tail of a horse: inferior officers of the crown were honoured by only one or two of these insignia. About the middle of the 17th century the Turkish empire comprised twenty-two *beglerbeglics*, or provinces governed by beglerbegs; these were subsequently reduced to three,—Roumelia, Anatolia, and Damascus,—and are now discontinued. The governors of the various provinces are pashas of two tails only. (Ubicini, 'Lettres sur la Turquie.')

BEGUINS, in ecclesiastical history, certain tertiaries or half-monks, who followed the *third* rule of St. Francis. They were called in Italy, Bizochi and Bocasoti; in France, Beguins; and in Germany, Beguards or Beghards; and are mentioned in ecclesiastical history of the middle age as early as the 11th century. The accounts however which both ancient and modern writers generally give of these famous names are so uncertain and so different from each other, that the history of the Beghards and Beguins is involved in greater perplexity than any other part of the ecclesiastical history of that period. Mosheim is minute upon the true origin of these denominations, both of which he considers to have been derived from the German *beggen*, or *beggeren* (now written *begehren*), to seek with importunity, by joining which to the syllable *hard*, which is the termination of many German words, we have the word *beggehard*, applicable to a person who asks any thing with great ardour, and from which the English word *beggar* is manifestly derived. These observations, on the origin and signification of the words in question, serve as a clue to the difficulties in which the history of the Beghards and Beguins has been involved; and, as Mosheim justly observes, will enable the reader to account for the prodigious multitudes of Beghards and Beguins which sprung up in Europe in the 13th century; and will show him how it happened that these denominations were given to above thirty sects or orders, which differed widely from each other in their opinions, their discipline, and manner of living. The Bizochi or Beguins, if we except their sordid habit and certain observances or maxims, which they followed in consequence of the injunctions of St. Francis, lived after the manner of other men, and were therefore considered in no other light than as seculars and laymen. (See the 'Acta Inquisit. Tholosanæ,' published by Limborch, pp. 307, 329, 382, 389, &c.; and Jordan's 'Chronicon,' published by Muratori, 'Antiquit. Ital. Medii Ævi,' tom. iv. p. 1020.)

We must not, however, says Mosheim, confound these Beguins and Beguines, who derive their origin from an austere branch of the Franciscan order, with the Beguines of the Netherlands, and afterwards of Germany, who crept out of their obscurity in the 13th century, and multiplied prodigiously in a very short time. Their origin was of earlier date than this century, but it was only now that they acquired a name and made a noise in the world. Their primitive establishment was undoubtedly the effect of virtuous dispositions and upright intentions. A certain number of pious women, both virgins and widows, in order to maintain their integrity, and preserve their principles from the contagion of a corrupt age, formed themselves into societies, each of which had a fixed place of residence, and was under the inspection and government of a female head. Here they divided their time between exercises of devotion and works of industry, reserving to themselves the liberty of entering into the state of matrimony, and quitting the convent whenever they thought proper. And as all those among the female sex who made extraordinary professions of piety and devotion were distinguished by the title of *Beguines*,—that is, persons who were uncommonly assiduous in prayer,—that title was given to the women of whom we are now speaking. The first society of this kind that we read of was formed at Nivelle in Brabant, in the year 1226, or, as other historians say, in 1207, and was followed by so many institutions of a like nature in France, Germany, Holland, and Flanders, that towards the middle of the 13th century there was scarcely a city of any note that had not its *beguinage*, or vineyard, as it was sometimes called in conformity to the style of the 'Song of Songs.' All these female societies were not governed by the same laws; but in the greatest part of them, the hours that were not devoted to prayer, meditation, or other religious exercises, were employed in weaving, embroidering, and other manual labours of various kinds. The poor, sick, and disabled Beguines were supported by the pious liberality of such opulent persons as were friends to the order.

In the 14th century the societies of the Beguines had become very numerous in Germany; but as they adopted some of the mysterious and extravagant opinions of the "Mystic brethren and sisters of the free Spirit," we find in the German records of this century a frequent distinction of them into those of the right and approved class and those of the sublime or free spirit, the former of whom adhered to the public religion, while the latter were corrupted by the opinions of the mystics. The Beguines now shared in the persecution which fell upon the mystics. The Clementina, as it is called, or constitution of the council of Vienna, A.D. 1311, against the Beguines, or those female societies who lived together in fixed habitations, under a common rule of pious discipline and virtuous industry, gave rise to a persecution of these people which lasted till the Reformation by Luther, and ruined the cause both of the Beguines and Beghards in many places; for though the pope, in his last constitution, had permitted pious women to live as nuns in a state of celibacy, with or without taking the vow, and refused a toleration only to such of them as were corrupted with the opinions of the Brethren of the free Spirit, yet the vast number of enemies which the Beguines and Beghards had, partly among the mechanics, especially the weavers, and partly among the priests and monks, took a handle from the Clementina to molest the Beguines in their houses, to seize and destroy their goods, to offer them many other insults, and to involve the Beghards in the like persecution. Pope John XXII. afforded the Beguines some relief under these oppressions, in the year 1324, by a special constitution, in which he gave a favourable explication of the Clementina, and ordered that the goods, chattels, habitations, and societies of the innocent Beguines should be preserved from every kind of violence and insult, which example of clemency and moderation was afterwards followed by other popes. On the other hand, the Beguines, in hopes of disappointing more effectually the malicious attempts of their enemies, embraced in many places the third rule of St. Francis and of the Augustines. Yet all these measures in their favour could not prevent the loss both of their reputation and substance, for from this time they were oppressed in several provinces by the magistrates, the clergy, and the monks, who had cast a greedy eye upon their treasures, and were extremely eager to divide the spoil. (See Mosheim's 'Eccles. History,' edit. 8vo, Lond., 1782, vol. iii., pp. 228, 229, 230, 231, 337, 379.) Mosheim intended a separate work upon the Beghards and Beguines, which never appeared, though he states himself, in his history, that it was then almost finished. The most copious writer on the long persecution of the Beguines is Christianus Wurstisen, or Urtisius, in his 'Chronicon Basiliense,' written in German, lib. iv., cap. ix., p. 201, fol., Basil, 1580.

There is a little work of great rarity, entitled 'Lettre de M. l'Abbé S * * * à Mlle. de G * * *, Béguine d'Anvers, sur l'Origine et le Progrès de son Institut.,' 12mo, Par., 1731, from which we learn that Beguinages, as they were called then, existed in more than forty towns of the Netherlands and the adjacent countries on the Rhine. It contains also two representations of a Beguine, one in the dress worn in the chapel of her house or convent, and the other in her walking habit. Communities of Beguines still subsist in Holland, Belgium, and Germany. Each house is governed by a prioress, who alone can permit or direct any of the sisters to go forth. A novitiate of three years is required before novices are admitted into the order, after which they assume the habit and take the vow, which consists only of a promise of chastity while they continue in the order, which however they are at liberty to leave when they think proper. The occupation of the Beguines is the education of young females and attendance on the sick, both in their private residences and in the public hospitals. Their principal establishment is now at Ghent, and numbers 600 inmates, the total number in Belgium being estimated at 6000. Their dress is black, with white veils; but that of the novices is varied, and those who have just taken the veil wear chaplets round their heads.

BEHEADING. [DECAPITATION.]

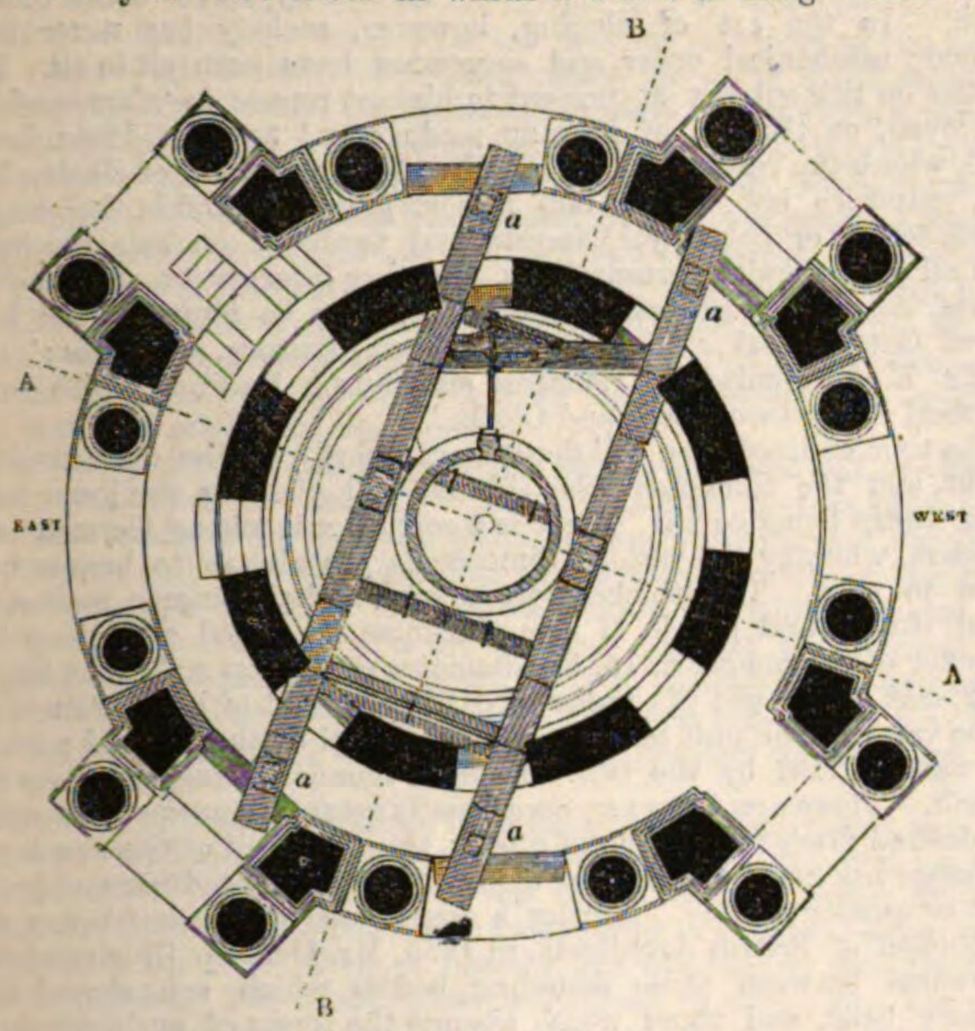
BEHEMOTH. [HIPPOPOTAMUS, IN NAT. HIST. DIV.]

BEIT is an Arabic word, which properly signifies a tent or hut, but is likewise employed to denote any edifice or abode of men. It is often found as a component part of proper names in the geography of those countries that have become subject to the Arabs: *Beit-al-Harâm*, 'the sacred edifice,' or 'the edifice of the sanctuary,' a designation frequently given to the temple of Mecca; *Beit-al-Mukaddas*, 'the sanctified abode,' Jerusalem; *Beit-al-Fakih*, 'the abode of the jurist,' a town in Yemen, &c. The Hebrew word, corresponding to the Arabic *Beit*, is *Beth*, which we find employed in a manner perfectly analogous in the Old Testament: in the name *Bethlehem* (in Arabic *Beit-Lahm*, or *Beit-al-Lahm*), 'the house of bread;' *Beth-Togarmah*, 'the house of Togarmah,' Armenia. The same word, *Beth*, is in Syriac still more extensively used as a component part of geographical names. In Arabian poetry, *Beit* signifies a distich.

BELED, or BALAD, is an Arabic word, which signifies a town, a province, or country, and is met with as a component part of many proper names in Oriental geography, for example, in Biledulgorid, which properly is *Balad-al-Jarîd*, the 'country of palm-trees.'

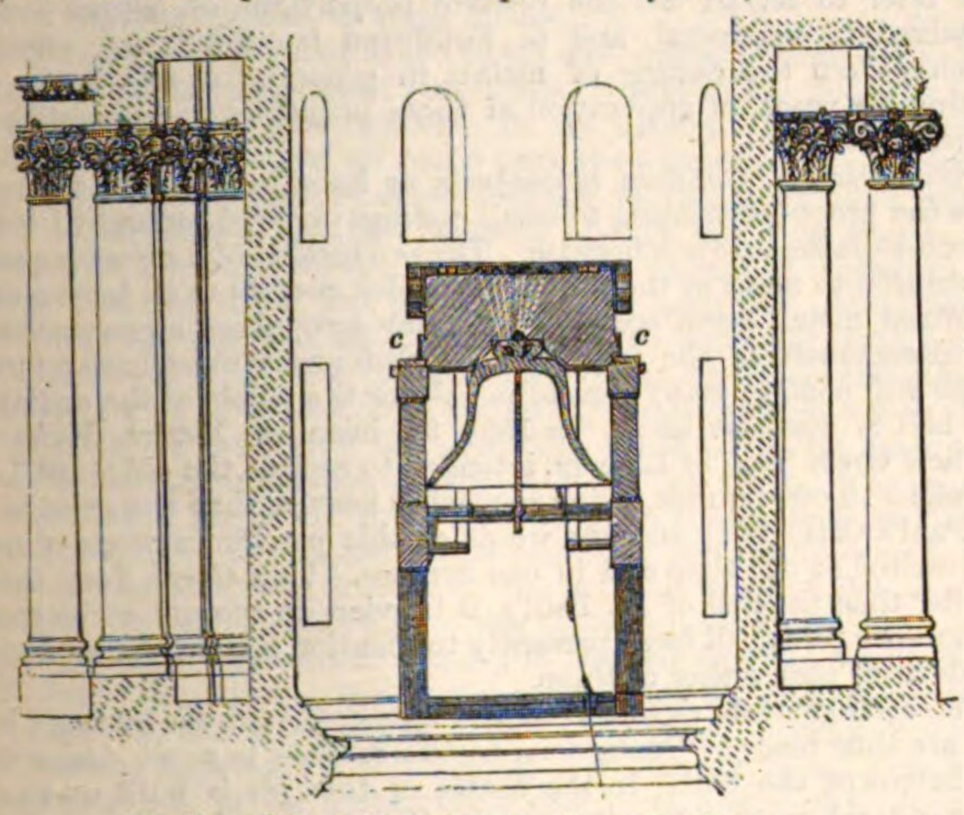
BELFRY, that part of a church-tower or steeple in which the bells are hung. The term is applied not only to that part of the tower, but also to the framing on which the bells are suspended. Belfry is probably derived from *belfredus*, a low Latin term of the middle ages, a compound of *bell* a Teutonic word, and *freid* (*freide*), peace, (Ducange, 'Gloss.') The old French word is *belfroit*. (Johnson's 'Dict.' by Todd.) Ducange gives also the forms *beaufroy* and *bellefroy*, and Viollet le Duc those of *baffraiz*, or *beffroi*, which latter word is used at the present day by French writers on architecture. Belfry is synonymous with *campanile* [CAMPANILE], which, with the terms *clocaria* and *tristegum*, was used by the writers of the middle ages to express the same thing. According to some, the name *belfredus* was applied to a

wooden tower used in attacking fortified places, and it was afterwards given to any elevated tower in which a bell was hung. This state-

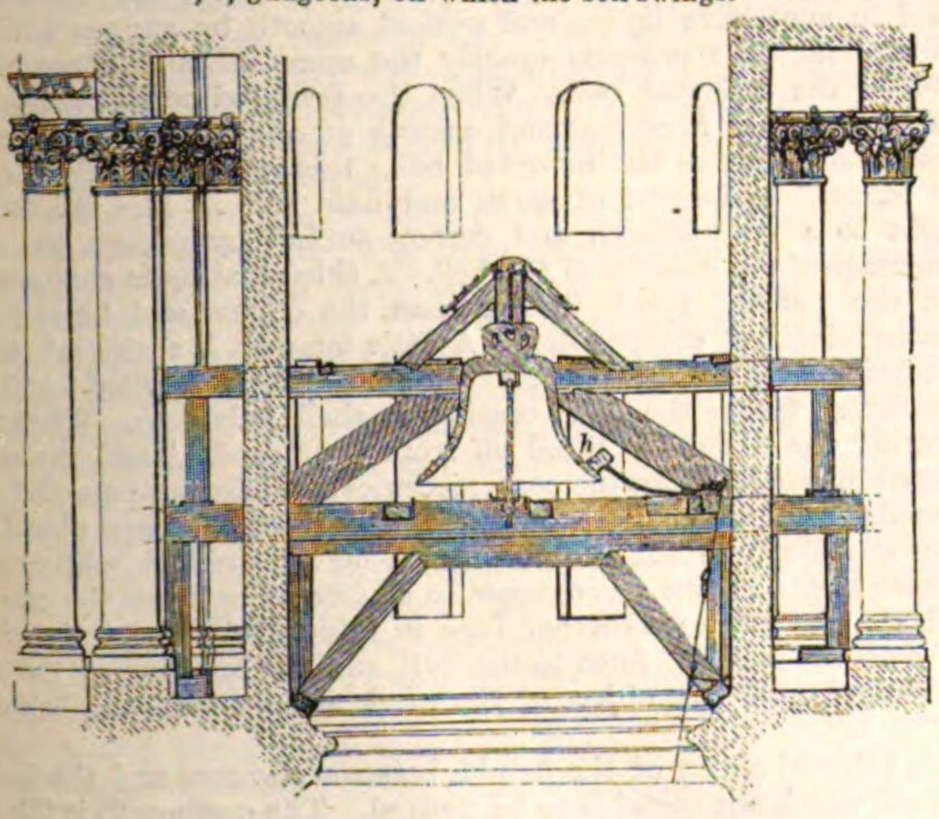


Plan of the Belfry of St. Paul's.
A and B, lines of sections; *a*, *a*, beams.

ment, if correct, might lead us to infer that the Latin word *bellum* (war) was the first part of the compound *belfredus*, and the second



Section of the belfry of St. Paul's on the line A, A
c, *c*, gudgeons, on which the bell swings.



Section of the belfry of St. Paul's on the line B, B.
h, hammer.

Scale of 0 1 2 3 4 5 10 20 Feet.

part possibly derived from the Latin *fero*, to bear or carry away. The forms *belfredus*, *verfredus*, and *beffroi*, also occur as the names of old military engines, and seem to lead to a different etymology.

In this plan and sections of the belfry of St. Paul's church are seen the construction of the timbers, showing their bearings independent of the masonry. This construction may be taken as a good example of the method of hanging heavy bells in a belfry. In the two towers of St. Paul's Church four bells are hung; in the southern tower three, and in the northern tower one. The great bell shown in the section is hung over two others in the south tower; these latter are fixed, and are not intended to be rung: the upper bell is hung on gudgeons or axles, and prepared for ringing, but from the confined space in which it is placed, it cannot be rung, and only moves on its axle when struck by the hammer of the clock.

In constructing a belfry, the frame-work is placed either on stone corbels, or is made to bear on a "recess formed in the wall." ('Encyc. Method. Arch.') This latter method is considered the best, because the vibration caused by the motion of the bells acts with less force on the masonry than it would if the framework were fixed in the masonry. It is also to be observed, that the higher the bells are placed in the tower, the more must the vibration, caused by ringing them, affect the masonry.

Village churches have belfries in their towers or steeples. In some instances, where there is a single bell, it is not placed in a tower, but suspended to a slight frame-work fixed between an arch constructed on the exterior top of the gable end of a church or chapel, which is either called a *bell cot*, in mediæval architecture, or a *bell gable* in modern pseudo-classical art. [BELL.]

BELGÆ, the general name given by Cæsar to the different tribes inhabiting the north of Gaul, between the sea on the west, the rivers Matrona (Marne) and Sequana (Seine) on the south, and the Rhenus (Rhine) on the east. But it is not well determined how far this name may be extended to the east; perhaps the Treviri, on the banks of the Moselle, were included. Cæsar remarks that the Matrona and Sequana separate the Belgæ from the Galli, who were to the south of them. He says also, in general and vague terms, that the Belgæ extend to the Lower Rhine, and lie towards the north and the rising sun. He also ('De Bell. Gall.' v. 24) uses the term Belgium to express the country of the Belgæ. The Belgæ were, according to Cæsar's testimony, of German origin, though probably wanting a name: to the inhabitants north of the Seine, he applied the name of some of the more considerable of the tribes to the whole. It would rather seem that the bulk of the people were of Celtic origin. Cæsar was informed by the Remi ('De Bell. Gall.' ii. 4) that most of the Belgæ were Germans, who had crossed the Rhine, and had expelled the Gauls. But this only applied to some of the tribes; and others, the Morini for instance, whose name is but a variation from that of Armorici, were Celts. All were distinguished by their warlike character, which Cæsar attributes partly to their origin and partly to their being strangers to luxury and refinement. The Bellovaci were the most warlike and numerous Belgic tribe in the time of Cæsar. ('De Bell. Gall.' ii. 4.) The Remi, whose capital was Durocortorum (Rheims), were the nearest Belgic tribe to the Galli on that side. The rest of the tribes are mentioned by Cæsar (ii. 4); among them we find one name, the Atrebates, the same as that of a tribe in Britain. The Belgæ may be described generally as occupying, in the time of Cæsar, the French departments of Nord, Pas de Calais, Somme, Seine Inférieure, Oise, and Aisne; with a part of modern Belgium.

When Cæsar invaded South Britain, he found that part of the island occupied by Belgæ, that is, by tribes of German origin, who had passed over from the opposite shores of Gaul, and obliged the original inhabitants to retreat into the interior of the country. ('De Bell. Gall.' v. 12.) But as he had no intercourse with the original inhabitants, it is impossible to say how far the Belgæ had penetrated inland; and later historians have given us no account of this circumstance. We learn only that the whole southern coast, from Suffolk to Devonshire, was occupied by Belgic tribes. The Cantii were settled in Kent, the Trinobantes to the north of the Thames, the Regni in Sussex, and the Atrebatii in Berkshire. To the west of them the Belgæ, properly so called, occupied Hampshire and Wiltshire, and extended through Somersetshire to the Bristol Channel; their capital was Venta Belgarum, Winchester. Farther to the west, the Durotriges were found in Dorsetshire, and their neighbours, the Damnonii, in Devonshire. This is taking the accounts of Cæsar and of Ptolemy together; Cæsar fixes the Belgæ in Kent and Sussex, Ptolemy in Hampshire, Dorsetshire, Wiltshire, and Somersetshire; but Wiltshire, by its ancient remains, shows that it was essentially Celtic. The names of these chief towns go far to show they were not German; Venta (Winchester), and Ischalis (Ilchester), are British: and Aquæ Solis (Bath) is Latin.

The Belgæ in Britain were most likely rather of the Celtic division of the Belgæ, than of the German; and, conformably to the character of their brethren in Gaul, made a stout resistance to Cæsar. But about a century afterwards they were compelled to submit to the yoke, which the Romans had already in the time of Cæsar imposed on their kinsmen in Gaul. The name Belgica occurs as the name of a division of Gaul as late as Diocletian's time. Under the emperors it was governed by an officer with the title of Procurator, or Legatus.

BELIAL, usually Bélial, more correctly Belíal, Βελίαλ, בְּלִיַּעַל (pronounce B'liyángal), is one of the few compound words in the Hebrew language. It is formed of בְּלִי *nothingness, not,* and יַעַל *utility, advantage.* Hence Belial means a worthless fellow. A man of Belial, or a son of Belial, a daughter of Belial, mean in the Bible a wicked person. Belial, if emphatically used, means the worst of spirits. Thus in the passage, "What concord hath Christ with Belial?" 2 Cor. vi. 15. Compare Milton's 'Paradise Regained,' book ii. 147-152 :—

> "So spake the old serpent doubting, and from all
> With clamour was assured their utmost aid
> At his command; when from amidst them rose
> *Belial*, the dissolutest spirit that fell,
> The sensuallest, and, after Asmodai,
> The fleshliest incubus, and thus advised."

Others have endeavoured to derive the word from עלל *to act,* so that Belial should be *a not acting one,* an *idle fellow:* others from עלה *to rise,* so that Belial should be one who should finally be cut down, *not to rise again.* The Talmudists in Sanhedrin, fol. 111, derive the word from עול or על *yoke.* According to them, Belial is *without a yoke, without restraint and discipline.* Compare Pfeiffer's 'Opera,' 1704, tom i. p. 503.

BELL; BELL FOUNDING. Whatever may have been the origin of these useful implements, bells of small size are undoubtedly very ancient. Small gold bells, intermixed with pomegranates, are mentioned as ornaments worn upon the hem of the high priest's robe, in Exodus chap. xxviii. v. 3, 4; and Calmet says that both were worn in the same manner by the kings of Persia. Among the Greeks we find hand-bells used in camps and garrisons. Plutarch mentions the use of the bell in the Grecian fish-market. The Romans had three chief appellations for the little bell, *petasus, codo,* and *tintinnabulum.* The hour of bathing among the Romans was announced by a bell, which was thence called by Martial *æs thermarum:* it was also in domestic use; was adopted, both as an ornament and an emblem, upon triumphal cars; and was fastened to the necks of cattle, that they might be traced when they strayed, particularly to the necks of sheep.

The large bells now used in churches are said to have been invented by Paulinus, bishop of Nola in Campania, about the year 400, whence the Nola and Campana of the lower Latinity. They were probably introduced into England very soon after their invention. They are first mentioned by Bede, about the close of the 7th century. Ingulphus records that Turketul, abbot of Croyland, who died about the year 870, gave to that abbey a bell of very large size, which he named Guthlac. His successor Egelric cast a ring of six others, to which he gave the names of Bartholomew, Bettelin, Turketul, Tatwine, Pega, and Bega. Pope John XIII., A.D. 968, consecrated a very large new cast bell in the Lateran Church, and gave it the name of John. The ritual for the baptising of bells may be found in the Roman Pontificale.

Sir Henry Spelman, in his 'Glossary' *v.* 'Campana,' has preserved two monkish lines on the subject of the ancient offices of bells:

> "Laudo Deum verum, Plebem voco, congrego Clerum,
> Defunctos ploro, Pestem fugo, Festa decoro."

And Brand quotes other monkish rhymes, which enumerate no less than sixteen purposes to which bells are, or may be, applied.

The *Couvre-feu,* or *Curfew Bell.* [CURFEW.]

The *Passing Bell* was so named, as being tolled when any one was passing from life. Hence it was sometimes called the *Soul Bell;* and was rung that those who heard it might pray for the person dying, and who was not yet dead. The number of times of tolling depended in some measure on the rank of the person. This practice is of high antiquity in England. We have a remarkable mention of it in the narrative of the last moments of the Lady Katherine (sister of Lady Jane) Grey, who died a prisoner in the Tower of London, in 1567. (Ellis's 'Letters.') The tolling of the passing bell certainly continued in use as late as the times of Charles II.

A *Sanctus,* or *Saint's-bell,* was so called, because it was rung when the priest came to those words of the mass, *Sancte, Sancte, Sancte Deus Sabaoth,* that all persons who were absent might fall on their knees, in reverence of the holy office which was then going on in the church. It was usually a small bell rung by hand, similar to those still in use in Roman Catholic churches, but it was also frequently placed where it might be heard farthest, in a lantern at the springing of the steeple, in a turret at an angle of the tower, or for the convenience of being more readily and exactly rung, within a cote or turret, between the church and the chancel; the rope in this situation falling down into the choir not far from the altar. Several of these turrets, and some with the bells in them, are still to be seen in our country churches.

Hawkins and Burney both mention the skill of English bell-ringers. The latter quotes from 'Tintinnalogia, or the Art of Ringing,' published in 1668; a work, he assures us, not beneath the notice of musicians who wish to explore all the regions of natural melody; as in this little book they will see every possible change in the arrangement of diatonic sounds, from two to twelve; which being reduced to musical notes, would point out innumerable passages, that, in spite of all which has hitherto been written, would be new in melody and musical composition. In the art of ringing, however, melody has never been studied; mechanical order and succession have been all in all. The treatise on this subject at present in highest repute is 'Campanologia Improved, or the Art of Ringing made easy,' 3rd edit. 12mo. Lond. 1733, where the reader will find all the terms explained of single, plain bob, grandsire bob, single bob minor, grandsire treble, bob-major, caters, ten-in or bob royal, cinques, and twelve-in or bob maximus, with all their regular permutations. Further information of a practical nature, as well as generally interesting, may be found in the Rev. Alfred Gatty's work, 'The Bell; its Origin, History, and Uses;' and in Mr. E. B. Denison's 'Lectures on Church Building; with some Practical Remarks on Bells and Clocks.'

The tone emitted by a bell depends conjointly on the diameter, the height, and the thickness; the thinner bell yielding the lower note, other things being equal. There is a sort of rule among German bell-founders, whereby the various dimensions are always to bear certain ratios to each. The thickest part, where the hammer strikes, is called the 'sound bow.' If this thickness be called $=1$, then the diameter of the mouth $=15$, the diameter of the top $=7\frac{1}{2}$, the height $=12$, and the weight of clapper $=\frac{1}{40}$th the weight of bell. According to the value of the unit in this formula, so will be the musical pitch of the tone yielded by the bell. English founders have each rules for himself. There are, however, occasionally great difficulties in ensuring any desired pitch in the tone of a bell; thus, the bell of the new Royal Exchange has never realised the expectations of its producers, either in pitch or quality of tone. During a lengthened discussion before the Institution of British Architects, in 1855, Mr. Denison illustrated the differences between those sounding bodies which are shaped like ordinary bells, and those which assume the forms of springs, spirals, hemispheres, forks, and gongs. Many of these yield deep and rich tones; but the ordinary bell, of given weight, throws out its sound to the greatest distance.

Passing from the antiquities to the mechanism of this subject, we may refer to ALLOY for the relative proportions of copper and tin contained in bell-metal, and to FOUNDING for the broad principles which govern the casting of metals in general. A few details concerning the practical application of these principles to bell-casting will be here given.

The casting of common house-bells or hand-bells differs in nowise from the processes relating to small castings in metal generally; but for church-bells the case is otherwise. The production of a *sonorous* quality, in addition to many of those qualities which pertain to all large castings in mixed metal, gives occasion for many scrupulous arrangements in the management of the foundry. A bell-foundry must have a furnace which will contain many tons of metal, for the whole of the casting for one bell is made at once. In 1835, for instance, Messrs. Mears cast the new Great Tom of Lincoln, intended to replace the old Great Tom; it weighs 12,000 pounds, being somewhat heavier than the great bell of St. Paul's Cathedral; and the whole of this ponderous mass of metal was melted at one time and in one furnace. This Great Tom, though smaller than the bell of St. Paul's, is heavier, on account of its greater thickness. We shall have presently to mention modern bells weighing much more than either of these.

The arrangements as to the central core or mould for casting a large bell are thus made:—Contiguous to the furnace is a pit, deeper than the height of the bell. In the centre of this pit is built up a rough mass of brick-work, somewhat smaller than the interior of the bell; and this is coated externally with a mixture of earth and horse-dung, applied in successive layers, and worked smooth by gauges until the *exterior* of the core presents exactly the same size and shape as the *interior* of the intended bell. When the prepared core is thoroughly dried by means of fires, a second coating of composition is laid on, of the same thickness as the intended bell; this coating, which is called the "model," is formed of earth and hair, and is, like the former, brought to a very smooth and correct surface by gauges, the exact counterpart of the exterior of the bell. A third coating is next applied, called the "shell," much thicker than the others, and formed of a somewhat different composition. A little tan-dust is sprinkled on the first coating, or core, before the second, or model, is applied; and also on the latter, before the outer coating, or shell, is laid on. When all is well dried, the "shell" is lifted off from the "model," and the model is picked or cut off from the core piecemeal. If we suppose the core, the model, and the shell to be three hemispherical cups placed one within another, and the middle one to be removed, it will serve to illustrate how a vacant space comes to be formed between the core and the shell; and when we further bear in mind that the exterior of the core gives the internal form to the bell, and the interior of the shell the external form, the object of the whole arrangement will be clearly seen.

This internal cavity of the mould, between the core and the shell, is that into which the metal is to be poured. The casting-pit is filled up with loam or earth, to the level of the top of the mould; a shallow channel is cut in the loam from the furnace to an orifice communicating with the vacant space in the mould; and two other orifices are left for the escape of air as the melted metal enters. Meanwhile the metal is being melted in the furnace. The tin employed is in the form

of blocks, brought from Cornwall; while the copper is old ship sheathing and other fragments. These are melted in a reverberatory furnace, by the heat of billets of wood, a kind of fuel less injurious to the metal than either coal or coke. All being ready, the earth which stops an orifice in the lower part of the furnace is knocked or dug away, a narrow jet instantly pours out from the opening, and a stream of liquid fire (for so it seems to the eye) runs along the channel in the loam, and flows into the mould, bubbling and hissing, and giving forth greenish sparks. When the mould is full, the metal is allowed to remain till perfectly cool; the loam is then removed, the external "shell" lifted or cut from the bell, the bell lifted off the core, and the core pulled down. If the bell be very large, it alone occupies the pit; but if of smaller size, such as from three or four to ten or twelve hundredweights, six or eight may be cast in one pit at one time.

The tone of a bell depends conjointly on the diameter and the thickness; a small bell or a thick bell giving, relatively, a more acute tone than one which is either larger or thinner. Hence the founder regulates the diameter and thickness according to the musical pitch of the tone which the bell is to yield; but as this cannot be rigidly attained by casting only, the bells (say a set to form chimes) are attuned by chipping away some of the metal with a sharp-pointed hammer; reducing the diameter at the lower edge when the tone is too low, and reducing the thickness at the part where the hammer strikes when the tone is too acute.

Many bells of considerable size have been constructed within the last few years. In 1845 Messrs. Mears, of Whitechapel, cast a bell for the south tower of York Minster. It was larger than any other at that time in the United Kingdom, being twelve tons in weight,—seven tons heavier than the Great Tom of Lincoln, and five heavier than the Old Tom of Oxford. The metal took twelve days to cool. The cost was about 2000*l*. This was, however, exceeded in size by one cast by the same founders for the Roman Catholic cathedral at Montreal. This bell is 8½ feet in diameter, and weighs 13½ tons (more than 30,000 lbs.) It required the melting of twenty-five tons of metal to effect the casting. The thickest part of the bell—the "sound-bow," where the clapper or hammer strikes—is eight inches.

The great bell at Westminster (which will probably first begin its regular working in the present year, 1859,) is interesting, not only for its vast size but for the incidents in its history. From its first planning to its completion no less a time than sixteen years elapsed; chiefly owing to the disagreements relating to the great clock with which it is associated. At the northern end of the New Houses of Parliament is the clock tower, a rectangular structure, rising to a height of 300 feet from the ground, or 326 from the foundation. In the centre of this is a shaft more than 200 feet high, with horizontal dimensions of 11 feet in one direction and 8½ feet in the other. Up the interior of this shaft was the only passage through which the great bell could be conveyed; and even then it had to be laid sidewise, that its dimensions might not exceed those of the shaft. The great clock stands at a height of about 160 feet from the ground, and the great bell about 40 feet higher. The bell-room was arranged with all the necessary apparatus for five bells: the greatest was to weigh about 14 tons, was to yield the note E, and was to be hung in the centre; the first quarter bell in one corner, yielding B, and weighing 4½ tons (more than St. Paul's great bell); the second quarter bell in another corner, with a note E♯, and a weight of 2 tons; the third quarter bell in a third corner, yielding F♯, and having a weight of 1½ ton; and a fourth quarter bell in the remaining corner, with a tone of G♯, and a weight of about 1¼ tons. All the five bells together, with their hammers, were estimated at 30 tons; the hammer and lever for the largest bell being alone nearly a ton. The harmonies (or rather melodies) of the quarter bells were thus arranged:—At a quarter-past the hour, G♯ F♯ E B; at half-past, E G♯ F♯ B, E F♯ G♯ E; at three-quarters, G♯ E F♯ B, B F♯ G♯ E, G♯ F♯ E B; and at the hour, E G♯ E B, E F♯ G♯ E, G♯ E F♯ B, B F♯ G♯ E.

Such was the plan laid down many years ago; and the actual results deviate only a little from it. The large bell received for a time the familiar appellation of Big Ben; but the new bell bears the more dignified title of St. Stephen. The bell is suspended from a large wrought-iron beam, two tons in weight, which has been tested by seventy tons' strain, without yielding more than one-fifth of an inch. The (first) great bell, designed by Mr. Denison, was (after a long series of disputes among commissioners, architects, and other persons concerned) cast by Messrs. Warner, at a foundry near Stockton-on-Tees, in August, 1856. The mould had been six weeks in preparation; and there were two furnaces, holding ten tons of metal each. Eighteen tons of metal were poured into the mould, producing a bell about 8 feet high, 9½ feet diameter at mouth, and weighing, when trimmed and adjusted, about 15 tons. Unfortunately, there was some flaw in the metal. The bell was conveyed to London, placed for a time at the foot of the clock tower, and struck for a short time one day in each week, that the public might hear the beauty of the sound. On one of these occasions the E became a dull and uncertain tone; the bell was found to be cracked; and it was then deemed fortunate that the discovery had been made before the ponderous mass had been raised to its place in the tower. After further discussion and delays, a new bell was cast; but the casting was in this case entrusted to Messrs. Mears. The second bell is somewhat lighter than the first, but yields the same note. It was raised to its place in October, 1858, and required mechanical appliances of a very complete kind; for the weight to be raised to a height of 200 feet, comprising bell, cradle, chains, and tackle, was not less than 25 tons, or 56,000 lbs. An inspection of the fragments of the first great bell, when broken up for recasting, showed that the metal exhibited much "speckiness," and was not in a state of aggregation suitable for the intended purpose. Altogether the cost of the great Westminster bell was not less than 3500*l*.

Mr. Denison, at the meeting of the Institution of British Architects above mentioned, gave a list of what he believed to be the largest bells known up to that time; it was as follows:—

	Weight. Tons.	Diam. Feet.	Thick. Ins.
Moscow (broken in 1737)	193	21	23
,, (fell in 1855)	63		
Pekin	53		
Novogorod	31		
Vienna (1711)	17¾	9·8	
Sens	15	8·6	
Westminster (planned)	14	9·2	9
Erfurt (1497)	13¾	8·6	
Notre Dame	12¾	8·6	7½
Montreal (1847)	12¾	8·6	8¼
Cologne	11¼		
York (1845)	10¾	8·3	8
Bruges	10¼		
St. Peter's	8		
Oxford (1680)	7½	7·1	6⅛
Antwerp	7¼		
Exeter (1675)	5½	6·3	5
Lincoln (1834)	5½	6·8	6
St. Paul's (1709)	5¼	6·7	
Ghent	5		
Boulogne	5		
Old Lincoln (1610)	4½	6·3	
Westminster, 1st quarter bell	4½	6·1	6

Other examples, collected by other authorities, are the following:—Olmütz, 18 tons; Breslau, 11; Görlitz, 10¾; Mechlin, 9; Halberstadt, 7½; Dantzic, 6.

BELL COTE, BELL GABLE, or BELL TURRET, in religious edifices a small pierced turret, or open termination of the western gable, in which one or more bells are hung. The bell gable is found in small churches or chapels which have no towers, and is often of very picturesque and pleasing form. In some instances it is a good deal enriched, in others nearly plain. Bell gables rarely occur in English churches of the Norman period; but are numerous in those of the 12th, 13th, and 14th centuries. In the chapel of St. Nicholas, Glastonbury, occurs a flat bell gable, pierced for two bells, with buttresses at the angles; and at Shipton Olliffe church, Gloucestershire, is a very good one of the turret form, also for two bells; these two examples, both of which are of about the middle of the 13th century, are engraved in Parker's 'Glossary of Terms used in Gothic Architecture.' There is an octagonal bell-turret pierced for two bells, of very good form, but of much later date at Corston church, near Bath. When a similar bell-turret occurs at the apex of the eastern gable of the nave, or over the chancel arch, it was intended to contain the sanctus or mass bell, or the bell which is rung in Roman Catholic churches at the elevation of the host. [BELL.] Several of these turrets still remain, and a few with the bell in them, as at Long Compton, Warwickshire (Parker's 'Glossary'). Bell-turrets of this kind are not infrequently met with in French churches of the 13th and 14th centuries, as at Villons, Calvados (De Caumont; Viollet le Duc).

BELL-METAL. An alloy of copper and tin used for bells, cymbals, gongs, or other sonorous bodies of a similar nature. The proportions usually adopted vary slightly according to the size of the bell to be made; but they may be stated generally to be 80 parts of copper to 20 of tin, or even occasionally 77 parts of copper to 23 of tin. Bell-metal in its natural state, that is to say, in the state in which it leaves the furnace and has become cool, is brittle; if, however, it should subsequently be heated, and then suddenly cooled (by dipping it in water containing some salts in solution), instead of becoming harder, it will become very ductile and malleable. The sonority of a mass of bell-metal thus chilled will be increased by a slow process of annealing.

BELLADONINE. An alkaloid of uncertain composition said to be contained in the leaves and stems of the deadly nightshade.

BELLA'TRIX, the name of the smaller of the two bright upper stars in Orion. The three stars of the belt rather incline towards it; it is of the second magnitude, and is marked γ by Rayer, and 24 by Flamsteed. The name (warrior) is indicative of the supposed astrological properties of the star; the old Arabic name is Al Mirzam al Nâjid, *the valiant lion*. [ORION.]

BELLES LETTRES, a vague term used by the French, which has been adopted by other nations, to signify various branches of knowledge, which are the produce of the imagination and taste, rather than of serious study and reflection. We do not find that the limits of this description of knowledge have been clearly defined. Rhetoric, poetry, history, philology, are generally understood to come within the definition of belles lettres; but the mathematical and natural sciences, jurisprudence, metaphysics, ethics, and theology, the fine arts, and the

mechanical arts, are considered distinct from them. Antiquarian and classical researches are not always included among the belles lettres : the French Academy 'des Inscriptions et Belles Lettres,' seems by its very title to make a distinction between the two, as the first part of the title, 'Inscriptions,' refers to the investigation of ancient or oriental inscriptions, medals, &c. Belles lettres may be said to answer to the *literæ humaniores* of the Latin language, and to the English expression "polite literature."

BELLONA, one of the group of small planets revolving between Mars and Jupiter. [ASTEROID.]

BELLO'NA, the goddess of war among the Romans, corresponding in some measure with Enyo of the Greeks; but as was observed under ARTEMIS, the habit of regarding the names of Greek and Roman deities as convertible, is one from which much confusion has arisen in the study of ancient mythology. As was then explained, the names of a very large proportion of the Roman deities have grown out of the language itself. Bellona is properly a feminine adjective, which with the noun *dea* signifies the goddess of war (from *bellum*, war). And on the principle which runs through the Roman mythology, of dividing every object of fear or desire between deities of each sex, Bellona presided over war with Mars or Mavors. By Roman writers she is spoken of as the companion of Mars, also as his wife, or sister. She is supposed by some to have been originally a Sabine deity, and her worship to have been introduced by the Sabine settlers in Rome.

The temple of Bellona was founded, according to Pliny (xxxv. 3), in the year 259 of Rome, by Appius Claudius, the colleague of P. Servilius Priscus. Livy, however (x. 19), refers the foundation to Appius Claudius Cæcus, the colleague of L. Volumnius, in the year of Rome 456; and the latter is confirmed by an inscription in Gruter (389. 4). Both accounts will be substantially true, if the latter only rebuilt the temple. When any Roman family had once connected its name with a public work, those who afterwards bore the name had a pride in keeping up the connexion. The temple was situated in the ninth region, between the Carmental Gate and the Flaminian Circus, and consequently without the walls of Servius. It was on this account the place usually selected by the Roman senate and consuls for the reception of embassies from hostile powers, and also of their own generals, especially when these came to claim a triumph; for the *imperium*, or supreme military authority, was at once annulled by an entrance into the city, and with it all claim to a triumph. Near the temple was a column, over which a spear was hurled as a declaration of war against any foreign state. (Ovid, 'Fasti,' vi. 201.) This rite was introduced to supply the place of another. According to the original ceremony, a herald, or *fecial*, proceeded to the frontiers, and hurled a spear of defiance into the hostile territory; but as the limits of the empire were extended, this became impracticable.

The goddess was usually represented as wearing a helmet, and bearing a shield in one hand, in the other a firebrand, a spear, or a lash. Sometimes she was blowing a trumpet, or uttering a war-cry and rushing to the combat. Her image is seen on the coins of the Bruttii, or Brettii. (Montfaucon, 'Ant. Ex.' i. 125.)

The wildest extravagance marked her worship. Her priests (Bellonarii), like those of Cybele and Bacchus, affected insanity (Juvenal, iv. 123), whirling their heads round with fearful rapidity, and shrieking out words of pretended prophecy. On the 24th of March, which was appropriately called the day of blood (*dies sanguinis*), they exhibited their zeal by making incisions in their arms, and sprinkling all around with their blood. The more prudent among her followers, however, contrived to produce the appearance of wounds without any self-torture, a laxity which the Emperor Commodus corrected by a special precept that the devotees of the goddess should make actual incisions; but, besides the priests officially attached to the worship of the goddess, there were volunteers, who, impostors or enthusiasts, frequented her temple and exhibited the same symptoms of phrenzy. Such scenes indeed were to be seen in the temples of other deities, but more particularly in that of Bellona. The wretched creatures were called *fanatici* (from *fano*, a temple), which though a term of reproach or compassion among the educated, was a title of honour in their own estimation, and proudly engraved on public monuments. See an inscription given by Gruter, 313, 1, "To Q. Cæcilius Apollinaris, fanatic of the temple of Bellona," and another in 312, 7.

The worship of Bellona was not unlike that of the goddess Ma, in the sacred cities of Cappadocia and Pontus called by the common name of Comana; and hence the Roman writers often use the title of Bellona when speaking of the Cappadocian goddess. Strabo in the same way calls her Enyo.

The earliest orthography of the name of the Roman goddess was Duellona, agreeing with *duellum*, the older form of *bellum*. [See article B, for the interchange of *du* before a vowel with *b*.]

BELLOWS. This term is applied not only to the common instrument in use, but also to any machine which serves to force a current of air against a fire. In general, however, it is more customary to apply the term blowing-machine to the larger species of apparatus. The principle of all these different adaptations of parts is the same, and is very similar to that of a forcing-pump. By one motion a vacuum would be made, if it were not for a valve which opens towards the incipient vacuum, and admits the air: by a contrary motion the air just admitted is expelled, not by the valve which is now closed, but by any other orifice.

When a furnace is to be supplied with a perpetual blast of air, it may have two separate bellows, worked by the same machinery, in such a way that one is discharging air while the other is receiving a new supply. The inconvenience of this construction is, that the blast, though perpetual, is not of uniform strength. The blast-furnaces of some of the great Welsh iron-works are worked by one huge air-pump, which condenses the air in spherical reservoirs, out of which the blast-pipes lead to the furnaces. In cases where a uniform and gentle blast is required, as in the organ, the air is condensed into a reservoir called the wind-chest, which supplies the pipes. [ORGAN.] A patent was obtained some years ago for a construction by which a perpetual and uniform blast is produced, applicable to the domestic bellows. It consists in a vaned wheel, which is enclosed in a vessel communicating with a tube, the vessel and tube being, in their longitudinal section, in form like that of a retort. A supply of air is obtained by holes in the side of the vessel, so that, on turning the vane by an exterior apparatus, the air is driven through the tube, and the blast thus created is permanently supplied by the lateral holes. These instruments are more effective than the bellows in common use; but they have effected little towards superseding the old familiar bellows.

The oldest representation of bellows is in the Egyptian paintings copied in the work of Rosellini. There are two pairs of bellows, one on each side of the fire, with which they are connected by long tubes of wood or cane, terminating in pointed metal snouts. A string is attached to each bellows, and the blower takes one string in his right hand and the other in his left. He presses with one foot on the bellows that is filled with air, at the same time raising his other foot from that which is just exhausted, and also pulling upwards with the string that is attached to it.

The largest kinds of bellows, with other contrivances for producing a powerful blast of air, will be more conveniently described under BLOWING MACHINE.

BELTEIN, or BELTANE, the name of a kind of festival, formerly observed in Ireland and Scotland, in most places on the 1st of May. In some parts of the west of Scotland it is observed on St. Peter's day, June 29. In Ireland we find two belteins, one on the 1st of May, the other on the 21st of June. To the beltein, also, in all probability, the fires which were formerly lighted in many parts of England on Midsummer Eve, are to be referred.

Beltein signifies the fire of Baal, the worship of whom is supposed to have existed in England, Scotland, and Ireland in the remotest period of druidical superstition. The Phœnician Baal probably denoted the Sun [BAAL], as Ashtaroth did the Moon. Beltein was therefore the fire lighted in honour of the Sun whose return and visible influence upon the productions of the earth was thus celebrated. *La na Beal tina*, and *neen na Beal tina*, in the Irish language, are the day and eve of Beal's fire. ('Fairy Legends and Traditions of the South of Ireland;' and MacCurtin's 'English-Irish Dict.' 4to, Par. 1732.)

The following account of the beltein is given in 'Focalóir Gaoidhilge-Sax-Bhéaria,' or an Irish-English Dictionary (by O'Brien), printed at Paris, 4to, 1768 :—"*Beáltine*, or *béil-tine*, ignis Beli Dei Asiatici: that is, *tine-Beil*, May-day, so called from large fires which the Druids were used to light on the summits of the highest hills, into which they drove four-footed beasts, using at the same time certain ceremonies to expiate the sins of the people. This pagan ceremony of lighting these fires in honour of the Asiatic god Belus, gave its name to the entire month of May, which is to this day called *mi na Beal-tine* in the Irish language. Dr. Keating, speaking of this fire of Beal says, that the cattle were driven through it and not sacrificed, and that the chief design of it was to keep off all contagious disorders from them for that year; and he also says, that all the inhabitants of Ireland quenched their fires on that day, and kindled them again out of some part of that fire. The above opinion about the cattle is confirmed by the following words of an old glossary, copied by Mr. Edward Lhuyd: *Da tene soinmech do guitis na druf the contincet laib moraib foraib: agus do berdis na ceatra entra or teomanduib cecha bliadna:* the main sense of which is, that the Druids lighted two solemn fires every year, and drove all four-footed beasts through them in order to preserve them from all contagious distempers through the current year." Brand in his 'Popular Antiquities,' gives an account of a number of superstitious observances and ceremonies connected with this custom.

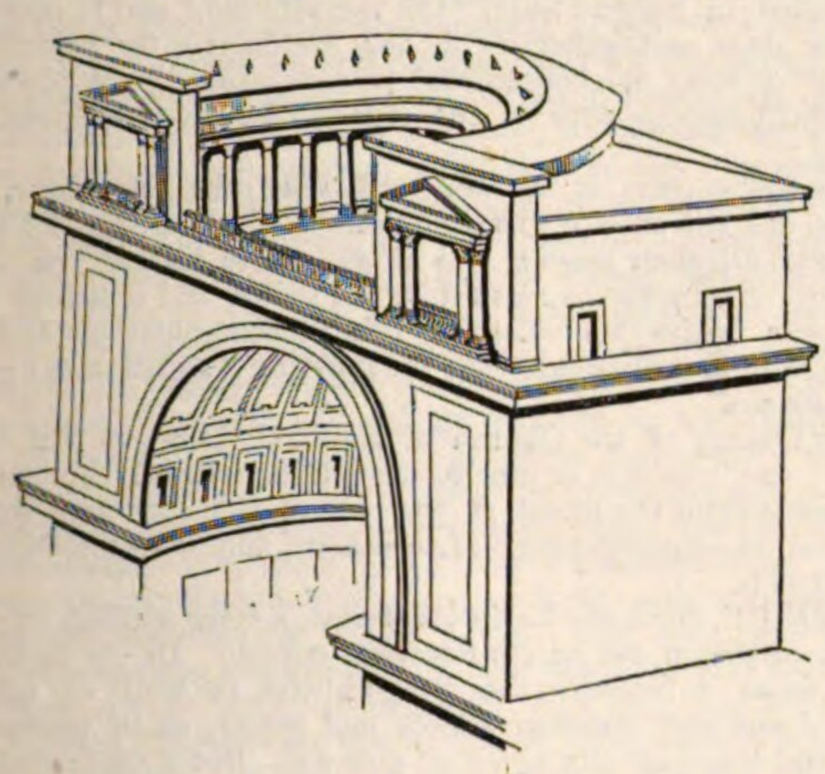
BELTS, JUPITER'S. [JUPITER.]

BELUS (בֵּל or בְּעֵל, βῆλος) was the name of the chief deity of the Babylonians and Assyrians, the same as Baal, the chief deity of the Semitic races [BAAL]. The Chaldee *Bel* (בְּעֵל), as well as the Hebrew *Baal* (בַּעַל), means *Lord*. The Greeks were apt to substitute Zeus for Belus, and the Romans Jupiter. The planet Jupiter was also worshipped under the name of Baal by the old Arabians as the chief star of happiness. The temple of Belus at Babylon was plundered and much damaged by Xerxes. Alexander gave orders for its restoration; but the priests being slack in executing the work, he intended to employ the whole army in rebuilding the temple. According to Herodotus (i. 7), Belus was the father of Ninus.

(See Isai. xlvi. 1; Jer. l. 2, li. 44; Baruch vi. 40; Herod. i. 178,

181-183; Diod. Sic. ii. 8, 10; Paus. i. 16, 3, viii. 33, 1; Plin. *Hist. Nat.* vi. 30, xxxviii. 55, 58; Arriani, *Anab.* iii. 16, vii. 16, 17; Cic. *Nat. Deor.* iii. 16; Norberg, *Onomast.* p. 28; Gesenius, *Jes.* vol. ii. pp. 286, 337, 358; Winer's *Realwörterbuch*, under Bel; Jahn, *Hebrew Antiquities*, § 407.)

BELVEDE'RE, in Architecture, is a small building constructed at the top of a house or palace, and open to the air, at least on one side, and often on all. The term is an Italian compound, signifying "a fine view;" and in Italy it is constructed expressly for that purpose, combined with the object of enjoying the cool evening breeze, which blows fresher on the house-top than in the confined streets. Many houses in Rome have belvederes, for the most part of a simple form. The most celebrated construction of this kind at Rome, which is in the Vatican, was built by Bramante in that part called the court of the



[View of the Belvedere of the Vatican, from a print in the British Museum.]

Belvedere. The form of this building is semicircular, and it stands over an enormous niche, a remarkable feature in the façade, of which the belvedere makes a part. From this belvedere the view is one of the finest that can be imagined, extending over the whole city of Rome and the Campagna, bounded by the distant Apennines, the tops of which are covered with snow for a large part of the year. Belvederes are not uncommon in France; but the term is applied rather to a summer-house in a park or garden, than to the constructions on the tops of houses, although small edifices, similar to those in Italy, are sometimes constructed on the tops of buildings for the purpose of commanding a fine view. Were buildings constructed in this country with a more thoughtful adaptation to their various purposes, a belvedere, suited to the particular locality, and not a mere unadapted copy of one of those of Italy, might often be made a very pleasing addition to an English mansion or villa residence. There is a small building in Windsor Great Park which is called a Belvedere.

It is not improbable that the wooden trellice-work, so common in the painted representations of buildings at Pompeii, was a construction similar in its purpose to the belvedere of the modern Italians. (*Plans and Elevations, in MSS. of the Vatican*, 3 vols. fol., and a *View of the Vatican in the King's Library, Brit. Mus.*; Gell's, and Mazois' *Pompeii, plates.*)

BEMA (*βῆμα*), was the pulpit, pedestal, or platform from which speakers addressed the public assemblies of the citizens of ancient Greece. The stone bema of the Pnyx at Athens still remains tolerably perfect, (except that the summit is broken,) with the seats from which it rises, and the steps by which it was ascended: its present height is about ten feet. (Wordsworth, 'Greece,' pp. 214, 215, ed. 1859; Murray's 'Handbook of Greece,' p. 186.)

The raised platform which formed the tribunal of the judge in the ancient Roman basilicas [BASILICA] was known as the bema, and hence when basilicas were adapted or imitated for Christian churches, the bishop's seat, in which he sat as well to adjudicate as to assist in the religious worship, was designated the bema. The term bema afterwards came to be applied to the entire sanctuary or holiest place of the basilica; the elevated seat of the bishop being placed at its farthest end, in the centre of the circle. The sanctuary of Greek churches is at the present day called the bema, but it is now always separated from the apsis by a solid wooden screen, which reaches to the ceiling.

BEN (בֶּן, constructed בֶּן־ or בְּן־, *son*) is the first syllable in many Hebrew names, which may be compared with our forms of names like Morrison, Johnson, Robertson, &c.: for instance, בֶּן־חֲדַד, *Benhadad*, is *the son* or the *worshipper of Hadad*, or Adod, the chief idol of the Syrians. בֶּן־אוֹנִי, *Benoni*, is *son of my pain*: בִּן־יָמִין, *Benjamin*, is *son of the right* (hand), that is, son of happiness. These examples show that not only literal sonship but also metaphysical relation is expressed by Ben. The construct state or regimen of a Semitic noun is that

shortening by which is expressed that it governs a following genitive as in the examples given.

BEN, OIL OF. An oil expressed from the fruit of the *Guilandina moringa*. It is a thick, slightly yellow fluid at 60° Fahr., and solid at lower temperatures. It is inodorous, and possesses a sweet taste. It does not readily become rancid, and is consequently used as a vehicle in perfumery. This oil has been examined by several chemists, but their results are somewhat discordant; it seems, however, to contain margaric and benic acids; and Walter states also, that stearic acid, and moringic acid ($C_{30}H_{28}O_4$) are amongst its constituents.

BENCH. [BANK.]

BENCHER. [INNS OF COURT.]

BENEDICTINE ORDER. The exact year when the monks who followed the rule of St. Benedict were first established as an Order is unknown. Although monks had been introduced from the East at least two centuries before the time of St. Benedict of Nursia, he may be considered, from the wide extension of the order, with its various branches, the great influence it acquired, and the real benefits it bestowed on society, to have been the real founder of monachism in Europe. The essence of the rule was that they were to live in a monastery subject to an abbot, to whom they owed implicit obedience; to observe silence and avoid laughter; to have no separate property; to submit to the very spare diet prescribed by rule; hospitality to be exercised towards strangers; mills, gardens, ovens, &c., to be provided, if possible, on the cloistral premises, the monks to work, and the workmen in the house to labour for the common profit. This last regulation gave birth to a great number of choice specimens of caligraphy and illumination; and Germany acknowledges the first important steps towards the clearing of their forests and improvements in agriculture and gardening, to the instruction and example of the Benedictine monks. The 'Histoire des Ordres Monastiques,' tom. v. 4to, Paris, 1718, upon Mabillon's authority, places the date of the monastery of Piombarole, near Monte Cassino, at least as early as the year 532, anterior to St. Benedict's death. The progress which this order made in the west, in a short time, was rapid. In France its interests were promoted by St. Maur, or Maurus, in Sicily by St. Placide, in Italy by St. Gregory the Great, and in Frisia, at a later period, by St. Wilbrod. The reciprocal protection afforded to the interests of the papal see by the Benedictine order, and to the interests of the Benedictine order, by the Roman pontiffs, sufficiently account for the order's advancement. There were nuns of this order as well as monks; but the time and original institution of the Benedictine nuns is quite uncertain; a tradition assigns it to St. Benedict himself, but the first historical mention of Benedictine nuns occurs in the 7th century.

The Benedictine order is said by many (see 'Monast. Angl.' vol. i.; Reyner, 'Apostol.' tr. i.; Stevens, vol. i.; and Mosheim, cent. vi. part ii. chap. ii.) to have been brought into England by St. Augustine and his brethren, A.D. 596, and to have continued from thence to the Dissolution under several improvements; but others (as Marsham in his 'Propulaion' prefixed to the 'Monasticon;' Patrick in his Additions to Gunton's 'History of Peterborough;' Hickes, 'Dissert. Epistolaris,' &c.) consider that the Benedictine rule was but little known in England till King Edgar's time, and never perfectly observed till after the Conquest. In the 'Decem Scriptores,' col. 2232, it is said that St. Wilfrid brought it into England A.D. 666, and in the 'Quindecem Scriptores,' and by Patrick in his Additions to Gunton, p. 247, with greater probability, that he improved the English church by it. It is expressly mentioned in King Kenred's charter ('Mon. Angl.' tom. i.) to the monks of Evesham, A.D. 709, and in the bull of pope Constantine, granted in the same year to that monastery. (See 'Mon. Angl.' ut supr.; Wilkins, 'Concil.' vol. i.; Spelm. vol. i.) But Bede, who has given us a very accurate account of the state of religion in this island till A.D. 731, has nothing of it; nor is there any mention of it in the first regulation of the monks in England by Archbishop Cuthbert in the great synod at Cloveshoe. (Wilkins, 'Concil.' vol. i.; Spelm. vol. i. A.D. 747.) If Wilfrid really advanced this rule, it was not over all England, but in Kent only. (See Patrick's Additions to Gunton's 'Peterborough.') And if the charter of King Kenred and the bull of pope Constantine be genuine (for all the ancient grants produced by the monks are not so), this rule, which is there prescribed to the monks of Evesham, is said in the bull to "have been at that time but little used in those parts." So that, instead of the Saxon monks being all Benedictines, there were probably but few such till the restoration of monasteries under King Edgar, when St. Dunstan and St. Oswald (who had been a Benedictine monk at Fleury in France) not only favoured the monks against the secular clergy, but so much advanced the Benedictines that William of Malmesbury ('De Gestis Pontif.' l. iii.) says this order took its rise in England from St. Oswald. The Ely historian (whose work is printed in Wharton's 'Anglia Sacra,' vol. i.) says, that King Edgar gave Ethelwold the manor of Suthborne, now Sudborn, in Suffolk, to translate the rule of St. Benedict into English, which seems to confirm the opinion of its being then but little known.

All our cathedral priories were of this order, except Carlisle, and most of the richest abbeys in England, Reyner ('Apostolat.' vol. i.) says, that the revenues of the Benedictines were almost equal to those of all the other orders. Tanner ('Notit. Monast.' lii.) enumerates one

hundred and thirteen abbeys, priories, and cells of this order in England, the sum of whose revenues, at the time of the Dissolution, amounted to 57,892*l.* 1*s.* 11*d.*, besides seventy-three houses of Benedictine nuns, whose revenues amounted to 7985*l.* 12*s.* 1*d.*, making a total of 65,877*l.* 14*s.*

The Benedictines, says Tanner, were much against all new orders of religions. By the second Lateran council they were obliged to hold triennial chapters, which those of this nation generally held at Northampton. (See Widmore, 'Hist. Westm. Ab.' pp. 79, 82.)

Fosbrooke, in his 'British Monachism,' has given an abstract of the Benedictine rule, chiefly from the 'Sanctorum Patrum Regulæ Monasticæ,' 12mo, Louv. 1571. It evidently received enlargements at different times, the whole of which were consolidated in the concord of rules promulgated by Dunstan in the reign of Edgar. (See the 'Concordia Regularum S. Dunstani Cantuariensis Archiepiscopi,' printed by Reyner in his 'Apostolatus Benedictinorum in Anglia,' Append. P. iii., and republished in the first volume of Dugdale's 'Monasticon.') This concord of rules regulated the practice of the English monks till the year 1077. The Clugniacs, Cistercians, Grandmontines, Premonstratensians, and Carthusians, were, in reality, branches only of the Benedictine order, living under the rule of St. Benedict, but observing a different discipline.

As the order increased in wealth and number corruptions gradually crept in, and various reformers arose at different times, who endeavoured to remedy these evils. Benedict of Aniano, in 817, formed new rules for the whole order; but other reformers, as St. Bernard, formed new orders under the names mentioned above. Notwithstanding all the attempts at reform, the old vices recurred with the acquisition of wealth, and immediately before the Reformation, the order counted between 15,000 and 16,000 monasteries; these were reduced almost immediately to between 5000 and 6000. At the beginning of the present century a large number of them were suppressed in France, Germany, and other continental countries, the estates distributed in various ways, the monks dispersed, either with a pension, to be employed in some court capacity, or to mix with the world as simple laics; and their excellent libraries, in most cases, taken possession of by the government. There has been since that time, a partial revival, but the number of houses now does not at most exceed 500.

The habit of the Benedictine monks was a black loose coat, or a gown of stuff reaching down to their heels, with a cowl or hood of the same, and a scapulary; and under that another habit, white, as large as the former, made of flannel; with boots on their legs. From the colour of their outward habit, the Benedictines were generally called Black Monks. (See Tann. 'Notit. Monast.,' pref.; and Fosbrooke, 'Brit. Monach.') Stevens, in his 'Continuation of the Monasticon,' vol. i., says, the form of the habit of these monks was at first left to the discretion of the abbots, and that St. Benedict did not determine the colour of it.

The habit of the Benedictine nuns consisted of a black robe, with a scapulary of the same, and under that robe a tunic of white or undyed wool. When they went to the choir, they had, over all, a black cowl, like that of the monks. (Fosbrooke's 'British Monachism,' 3rd edit. 1844.)

BENEDICTION, the act of invoking the favour of God, prosperity, long life, and other blessings upon individuals. The word is derived from the Latin, *benedicere*, which originally meant "to speak well," or "to praise or commend," and was afterwards employed for "to wish well." (See Ducange's 'Glossarium.') The ceremony of blessing is of a very remote antiquity. We find in the Scriptures that the patriarchs before they died, solemnly bestowed their blessing on their sons. Isaac giving by mistake to his younger son Jacob the blessing which he intended for his elder son Esau (Genesis xxvii.), is an interesting instance of this custom. In Numbers vii. 23-26, the words are specified in which the high priest was to bless the people of Israel. Aaron blessed the people, "lifting his hand towards them." (Leviticus ix.) Christ after his resurrection, and before parting from his disciples at Bethany, "lifted up his hands and blessed them." (St. Luke xxiv. 50.) In the early church, the bishop gave his blessing to the people with his hands extended towards them. In the Roman Catholic church it is the custom for the bishop to lift up his right hand towards the people with the fingers extended, and with it to describe the sign of the cross, in commemoration of the Redemption. The benediction, "Benedictio super populum," is also given by the bishop from the altar in the mass service, with the words "Benedicat vos Omnipotens Deus." The priests also give the benediction, but with some difference in the form and words, and they can only give it at mass, or while administering the sacrament, or in other solemn ceremonies; but the bishop has the power of giving it any where or upon any occasion he may think fit. In the Roman Pontificale are found the various forms of benediction. One of the most impressive instances of this ceremony is that of the pope in full pontificals, attended by the cardinals and prelates, giving his benediction "Urbi et Orbi" on Easter Sunday after mass, from the great gallery in the front of St. Peter's church, while the vast area beneath is filled with kneeling spectators.

The benediction forms an essential part of many ceremonies of the Roman Catholic church, such as the coronation of kings and queens, the confirmation of abbots and abbesses, the consecration of churches, altars, and sacramental vases. These are all performed by the bishop, and are accompanied by different ceremonies, such as anointing, imposing of hands upon the head of the person consecrated, &c. The benediction of church utensils, of bells, of sacerdotal garments, of churchyards, &c., may be performed by priests. The nuptial benediction, which is an essential part of the marriage ceremony, is given by the parish clergyman. The priests also in some instances give benediction to houses, fields, horses, cattle, &c., by sprinkling them with holy water. This custom of blessing those things which are for the use or support of man is of great antiquity. It is found in St. Gregory's 'Sacramentale,' and, before him, in that of Pope Gelasius I., who lived in the 5th century. The "benedictio mensæ et ciborum," was a general practice among all Christians before sitting down to dinner: the English custom of saying grace is a continuation of it.

There is also in Roman Catholic churches a service which is commonly called, in Italy at least, "the Benediction," and is performed on particular days, and generally in the evening; after certain prayers being said or sung, the consecrated host is raised up by the officiating priest, who describes with it the sign of the cross towards the congregation.

The benedictorium is the vase containing the holy water, which is placed at the entrance of Roman Catholic churches for the use of the people, who dip their fingers into it and cross themselves as they go in and out. The water is blessed by the priest, and is mixed with salt.

The pope begins his bulls and other communications addressed to Roman Catholic individuals with the greeting "Salutem et apostolicam benedictionem."

In the Liturgy of the Church of England there are but two benedictions: one, which is as much a supplication by all the congregation as a blessing from the priest, at the end of the prayers; the other is introduced on administering the sacrament, and pronounced at the end of the sermon.

BENEFICE, from the Latin *beneficium*, a term applied by the canon law to a provision for an ecclesiastical person. In its most comprehensive sense it includes the temporalities as well of archbishops, bishops, deans and chapters, abbots and priors, as of parsons, vicars, monks, and other inferior spiritual persons. But a distinction is made between benefices attached to communities under the monastic rule (sub regulâ), which are called *regular* benefices, and those the possessors of which live in the world (in sæculo), which are thence called *secular* benefices. The writers on the canon law distinguish, moreover, between simple or sinecure benefices, which do not require residence, and to which no spiritual duty is attached but that of reading prayers and singing (as chaplainries, canonries, and chantries), and *sacerdotal* benefices, which are attended with cure of souls.

Lord Coke says, "Beneficium is a large word, and is taken for any ecclesiastical promotion whatsoever." (2 'Inst.' 29.) But in modern English law treatises the term is generally confined to the temporalities of parsons, vicars, and perpetual curates, which in popular language are called livings; the legal possessor of a benefice attended with cure of souls being generally called the incumbent.

The history of the origin of benefices is involved in great obscurity. The property of the Christian Church appears, for some centuries after the apostolic ages, to have been strictly enjoyed in common. It was the duty of the officers called deacons (whose first appointment is mentioned in Acts, chap. vi.) to receive the rents of the real estates, or *patrimonies* as they are called, of every church. Of these, as well as of the voluntary gifts in the shape of alms and oblations, a sufficient portion was set apart, under the superintendence of the bishop, for the maintenance of the bishop and clergy of the diocese; another portion was appropriated to the expenses of public worship (in which were included the charge for the repairs of the church), and the remainder was bestowed upon the poor. This division was expressly inculcated by a canon of Gelasius, bishop of Rome, A.D. 470; and after the payment of tithes had become universal in the west of Europe, as a means of support to the clergy, it was enacted by one of the capitularies of Charlemagne, that they should be distributed according to this division. When the bishoprics came to be endowed with estates, the bishops, to encourage the foundation of churches, and to establish a provision for the resident clergy, gave up their portion of the tithes, and were afterwards by the canons forbidden to demand it, if they could live without it. Although the revenues of the Church were thus divided, the fund from which they were derived remained for a long time entirely under the same administration as before. But by degrees every minister, instead of carrying the offerings made in his own church to the bishop for the purpose of division, began to retain them for his own use. The lands also were apportioned in severalty among the resident clergy of each diocese. These changes were not, however, made in all places or all at one time, or by any public edict, but by insensible degrees, as all other customs are introduced. "Some writers have attributed the origin of parochial divisions to a period as early as the 4th century: and it is not improbable that this change took place in some parts of the Eastern Empire, either in that or the succeeding age. Some of the constitutions of Justinian seem to imply that in his time (the beginning of the 6th century) the system of ecclesiastical property, as it existed in the East, was very similar to that which has prevailed in Catholic countries in modern times." For the churches, monasteries, and other pious foundations possessed landed and other property (slaves among the rest), which, by the constitutions of Justinian, they are restrained from

alienating as they had been in the habit of doing to the detriment of their successors. (Father Paul's 'Treatise on Ecclesiastical Benefices.')

The general obscurity that hangs over the history of the middle ages prevents us from ascertaining, with precision, at what period the changes we have alluded to were introduced into the west of Europe. This, however, seems clear, that after the feudal system had acquired a firm footing in the west of Europe, during the 9th and 10th centuries, its principles were soon applied to ecclesiastical as well as lay property. Hence, as the estates distributed in fief by the sovereigns of France and Germany among their favoured nobles, were orignally termed *beneficia* [BENEFICIUM], this name was conferred, by a kind of doubtful analogy, upon the temporal possessions of the Church. Thus, the bishoprics were supposed to be held by the bounty of the sovereigns (who having by degrees obtained, had now usurped the right originally vested in the clergy and people, of filling them up when vacant), while the temporalities of the inferior ecclesiastical offices were held of the bishops, in whose patronage and disposal they for the most part then were. The manner of investiture of benefices in those early times was probably the same as that of lay property, by the delivery of actual possession, or of some symbols of possession, as the ring and crozier, which were the symbols of investiture appropriated to bishopries.

Benefices being thus endowed, and recognised as a species of private property, their number gradually multiplied during the ages succeeding that of Charlemagne. In England especially several causes contributed to the rise of parochial churches. "Sometimes (Dr. Burn, 'Eccles. Law,' tit. *Appropriation*) the itinerant preachers found encouragement to settle amongst a liberal people, and by their assistance to raise up a church and a little adjoining manse. Sometimes the kings, in their country vills and seats of pleasure or retirement, ordered a place of worship for their court and retinue, which was the original of royal free chapels. Very often, the bishops, commiserating the ignorance of the country people, built churches as the only way of planting or keeping up Christianity among them. But the more ordinary method of augmenting the number of churches depended on the piety of the greater lords; who, having large fees and territories in the country, founded churches for the service of their families and tenants within their domains. It was this that gave a primary title to the patronage of laymen, and made the bounds of a parish, in many cases, commensurate to those of a manor: and it was this distinct property of lords and tenants that by degrees allotted new parochial bounds, by the adding of new auxiliary churches." [ADVOWSON.]

It appears, however, that if there were any new fee erected within a lordship, or there were any people within the precinct not dependent on the patron, they were at liberty to choose any neighbouring church or religious house, and to pay their tithes and make their offerings wherever they received the benefits of religion. This by degrees gave rise to the arbitrary appropriation of tithes, which, in spite of positive enactment, continued to prevail till the end of the 12th century, when Innocent III. by a decretal epistle to the archbishop of Canterbury, enjoined the payment of tithes to the ministers of the respective parishes where every man dwelt. This injunction has been complied with ever since, so that it is now a universal rule of law in England, that tithes are due of common right to the parson of the parish. [TITHES.]

The 12th century was also the era of an important change in the manner of investiture of ecclesiastical benefices in England. Up to this time the simple donation of the patron was sufficient to confer a legal title to a benefice, provided the person to whom it was given was in holy orders, for otherwise he must be first presented to the bishop, who had power to reject him in case of unfitness; but the popes, who had in the 11th and 12th centuries successfully contended against every other species of ecclesiastical investiture being exercised by laymen, now procured that the presentation of the patron should not be of itself sufficient to confer an ecclesiastical benefice, even though qualified by the discretionary power of rejection (in case the benefice was given to a layman), which was already vested in the bishop. This was the origin of the ceremonies of *institution*, which is the mode of investiture of the spiritualities; and *induction*, which is the mode of investiture of the temporalities of a benefice. Where the bishop was the patron of the benefice, the two forms of *presentation* and *institution* were united in that of *collation*. But this is not the place to treat of the origin and nature of ecclesiastical patronage in England as a subject of property, the rules of law which apply to it as such, the limitations within which and the forms according to which it must be exercised, or the mode by which it may be vindicated. These, and the respective rights of the bishop, the archbishop, and the crown, in the case of lapse, are treated of under more appropriate heads. [ADVOWSON; QUARE IMPEDIT.]

Although the popes, in denying to laymen the right of ecclesiastical investiture, had still left them in possession of the substantial part of the patronages of benefices, even this privilege was for some centuries not only very much questioned, but in many instances entirely wrested from them by papal encroachment.

The first attacks by the popes upon the rights of private patrons (which took place towards the latter end of the 12th century) assumed the form of letters of request called 'mandates' or 'expectatives,' praying that benefices might be conferred on particular individuals. What was first asked as a favour was soon claimed as a right, and rules

were laid down as to grants and revocations of expectatives. The popes next proceeded to claim the patronage of all benefices *vacantia in curiâ*, that is, which fell vacant by the incumbents dying at the court of Rome. The number of these, through the management of that court, which contrived on various pretences to draw ecclesiastics of all ranks to Rome from different parts of Europe, became by degrees very considerable. But Clement V. in the beginning of the 14th century went beyond all his predecessors, by laying it down broadly as a maxim, that the full and free disposition of all ecclesiastical benefices belonged to the pope. (Clementines, lib. ii. tit. 5, c. 1.) It followed as a consequence from this principle, that the pope could make reversionary grants or *provisions*, as they were called, during the lives of the incumbents; and that he could reserve such benefices as he thought fit for his own peculiar patronage. At the same time, dispensations from the canons against non-residence and pluralities, and permissions to hold benefices *in commendam* were freely granted, so that by these and similar means, in some instances fifty or sixty preferments were held by the same person at once. The evils of this system were felt all over Europe. The best benefices were everywhere filled with Italian priests, ignorant alike of the language and habits of the people to whose spiritual wants they were bound to minister. England in particular suffered so much from papal encroachments during the reign of Henry III., that the English deputies at the Council of Lyon (A.D. 1245) complained to the pope that the foreign clergy drew annually from England upwards of 70,000 marks. This remonstrance produced no effect, but the system at length became so intolerable, that a determined plan of opposition to it was gradually formed in the principal nations of western Europe. In this opposition our own ancestors took the lead, and their efforts were in the end completely successful. The parliament, assembled at Carlisle 35 Edw. I., wrote a strong remonstrance to Clement V. against the papal encroachments on the rights of patronage, and the numerous extortions of the court of Rome. This appears to have produced no effect, but it may be cited as a proof of the spirit of the times. The government of Edward II. was too feeble to act; but Edward III. was a prince of very different character. After complaining ineffectually to Clement VI. of the abuse of papal reservations, he procured the famous Statute of Provisors (25 Ed. III. stat. 6); which provided that all elections and collations should be free according to law, and that in case any provision, collation, or reservation should be made by the court of Rome of any archbishopric, bishopric, dignity, or other benefice, the king should for that turn have the collation of such archbishopric or other dignities elective, &c.

This statute was fortified by several others in this and the succeeding reigns, 27 Ed. III. stat. 1, c. 1; 38 Ed. III. stat. 1, c. 4; 3 Rich. II. c. 3; 7 Rich. II. c. 12 (which enacts that no alien shall be capable of being presented to any ecclesiastical preferment); 12 Rich. II. c. 15; 13 Rich. II. stat. 2, cc. 2 & 3; 16 Rich. II. c. 5; 2 Hen. IV. c. 3; 7 Hen. IV. c. 8; 3 Hen. V. c. 4. These statutes, which inflict very severe penalties on persons endeavouring to enforce the authority of papal bulls and provisions in England, are sometimes called, from the initial words of the writ issued in execution of the process under them, the statutes of *præmunire*; and the offence of maintaining the papal power is from this origin usually designated by that term. [PRÆMUNIRE.] The statutes against papal provisions (though not very strictly enforced) remained unrepealed, in spite of the frequent attempts of the popes and their adherents to obtain their abrogation.

The rights of ecclesiastical patronage having been thus solemnly vindicated by parliament, have, in their fundamental principles, remained unaltered to the present time. The ceremonies of *presentation* and *institution* in the case of lay patrons, and of *collation* where the bishop is patron, are still necessary to give a title to all benefices with cure of souls, except those which are technically called perpetual curacies and donatives; and the title so given is incomplete without corporal *induction* into possession of the temporalities of the benefices. There are, also, certain acts enjoined either by the canon law or statute, the non-performance of which will subject the incumbent to deprivation of the benefice into which he has been lawfully inducted.

There is no difference between institution and collation as to the action itself, but they differ somewhat in their respective consequences. Thus, by institution, the church is said to be full against all persons but the crown, and if it has been full for the space of six months, this is a sufficient answer to any action by private persons, or even by the sovereign, where he claims as a private patron and not by royal prerogative, as in case of lapse, or otherwise. But, by collation, the church is not full, so as to render a plea to that effect available in the temporal courts, except against the collator. Every clerk before institution or collation is required by the canon law to take the oath against simony, and the oath of canonical obedience to the bishop, and to declare by subscription his assent to the doctrine of the royal supremacy, to the Book of Common Prayer, and the Thirty-nine Articles. The subscription to the Thirty-nine Articles is also imposed by statute 13 Eliz. c. 12, upon all persons to be admitted to any benefice with cure of souls. Moreover, the statute 1 Eliz. c. 1, and 1 Will. & Mary, c. 8, sec. 5, require that every person collated or promoted to any ecclesiastical benefice shall, before he takes upon himself to supply or occupy the same, take the oaths of allegiance and supremacy, for which, however, one form of oath has now been substituted. [ALLEGIANCE.] The statute 13 & 14 Car. II. c. 4 (the Act of Uniformity),

requires every parson and vicar before his admission to be incumbent, to subscribe a declaration of conformity to the Liturgy of the Church of England as by law established.

The acts of institution or collation so far confer a right to the temporalities of the benefice, that the clerk may enter upon the glebe land and take the tithes, but he cannot sue for them or grant them until induction. By induction the church becomes full, even against the crown, and the clerk is seised of the temporalities of the benefice, and invested with the full rights and privileges of parson; but by the Act of Uniformity he must, within two months after he is in actual possession of his benefice, upon some Sunday, openly before his congregation, read the morning and evening prayers, and declare his assent to the Book of Common Prayer, on pain, in case of neglect or refusal, of being *ipso facto* deprived of his benefice. The same statute obliges him, on pain of deprivation, to read publicly, within three months after his subscription to the declaration of conformity to the Liturgy, the bishop's certificate of his having made such subscription, together with the declaration itself. The statute 23 Geo. III. c. 28, however, makes an exception where the incumbent is prevented by some lawful impediment, to be allowed and approved of by the ordinary of the place. The same penalty of deprivation is imposed by 13 Eliz. c. 12, in case of an incumbent failing, within two months after induction, to read publicly in the church the Thirty-nine Articles, and to declare his assent to them. The 23 Geo. III. c. 28, provides, that, in case of sickness or other lawful impediment, it shall be deemed a sufficient compliance with the statute of Elizabeth if the incumbent reads the Articles, and declares his assent to them at the same time that he declares his assent to the Book of Common Prayer. The parson must, within six months after his admission to the benefice, take the oaths of allegiance in one of the courts at Westminster, or at the general quarter sessions of the peace, on pain of being incapacitated to hold the benefice, and of incurring certain other disabilities therein specified. Such are the means by which a clerk's legal title as parson, rector, or vicar is acquired, asserted, and completed.

Every parson or rector of a parish with cure of souls, and where the parsonage is appropriated, every vicar or perpetual curate, though in his natural capacity an individual, is in contemplation of law a body corporate, with perpetuity of succession. The rector or parson is seised of the freehold of the parsonage house and glebe lands, as well as the tithes of the parish, except where a special exemption from the payment of tithes exists by prescription or otherwise; but owing to the practice of appropriation, which formerly prevailed to a great extent in England, and has been attended with very remarkable consequences, these are frequently vested in laymen, who have vicars or curates under them to perform the spiritual duties. [Advowson.] This custom was not confined to spiritual corporations aggregate, but deans and other officers in cathedrals, and in some places even parish priests, procured the privilege of appointing a vicar to perform the spiritual duties of the church, while its revenues were appropriated to themselves and their successors. Hence it happens that in some places a rector and vicar are instituted to the same church; in which case the rector is excused from duty, and the rectory is called a sinecure benefice, as being *sine curâ animarum*. In order to effectuate an appropriation it was necessary that the patron should obtain the consent of the crown and of the bishop, as each of these had an interest in the patronage of the church in case of lapse, which, as a corporation never dies, could not take place after the appropriation. Upon the making an appropriation, an annual pension was formerly reserved to the bishop and his successors, called an indemnity, and payable by the body to whom the appropriation was made. In an ancient deed of appropriation preserved at Canterbury, the ground of the reservation is expressed to be for a recompense of the profits which the bishop would otherwise have received during the vacancy of the benefice.

After the appropriation the appropriators and their successors became perpetual parsons of the church; but if the corporation were dissolved, the perpetuity of persons being gone, the appropriation ceased, and the church recovered its rights.

This principle would have come into extensive operation at the time of the dissolution of the monasteries in England, if the legislature had not expressly provided against it. By the statutes 27 Henry VIII. c. 28, and 31 Henry VIII. c. 13, the possessions of these religious houses, and by a subsequent statute, 32 Henry VIII. c. 24, those of the Knights of St. John of Jerusalem, were all vested in the crown. In each of these statutes, parsonages and tithes are expressly included, and the first two confirm the royal grants made or hereafter to be made of this property. Tithes are also included in two subsequent statutes, 37 Henry VIII. c. 4 and 1 Edward VI. c. 14, by which the possessions of chantries and religious fraternities are given to the crown. The last of these statutes empowers the commissioners, therein referred to, to ordain and sufficiently endow vicars in perpetuity in parish churches annexed to the religious fraternities whose possessions were confiscated by that act; and also to endow in perpetuity a schoolmaster or preacher in such places where the religious fraternities or incumbents of chantries were bound by the original foundation to keep a schoolmaster or priest. The property acquired by the crown from the above-mentioned sources, and from the dissolution of alien priories in the reign of Henry V., was freely bestowed by the kings of England, especially Henry VIII., not only upon spiritual persons and corporations, but upon laymen. Hence

it is that there are so many instances in England at the present time, of not merely the right to tithes, but the property of entire rectories being vested in laymen. These benefices are sometimes called lay, but more commonly impropriate, rectories, as being (according to Spelman) improperly in the hands of laymen. The rector is in that case termed the impropriator; but this appellation is now indiscriminately applied not only to lay individuals and corporations, but to all spiritual persons and corporations who, either by virtue of ancient appropriations, or by grants from the crown since the dissolution of the religious fraternities, are entitled to the tithes and other revenues of the Church, without performing any spiritual duties. By statute 32 Henry VIII. c. 7, the remedies which the law had provided in the ecclesiastical courts for the subtraction of tithes are communicated to laymen, and their title to tithes is put on the same footing with that to land, by giving them the same or similar actions for vindicating their estates in those and other ecclesiastical profits against all adverse claimants whatsoever. In short, tithes and other fruits of benefices, when vested in laymen, are liable to the same process of execution for debt, and subject to the same incidents of alienation, descent, escheat, and forfeiture as all other incorporated real property. Moreover, by statute 43 Eliz. c. 2, tithes impropriate are made liable to poor-rates. They are also included in the Land-tax Acts; and by the Statute of Limitations, 3 & 4 Will. IV. c. 27, actions and suits for their recovery are subject to the same periods of limitation as those for the recovery of land.

Another consequence of appropriation in England, besides the vesting of the possessions of the Church in laymen, was the endowment of vicarages. The appropriating corporations at first used to depute one of their own body to reside and officiate in the parish churches by turns or by lot, and sometimes by way of penance; but as this practice caused scandal to the Church, especially in the case of monastic orders whose rules were thereby violated, the monks by degrees ceased to officiate personally in the appropriated churches, and this duty was committed to stipendiary vicars or curates, who were however removable at the will of the appropriators. One of the numerous pretexts urged by the monastic bodies for obtaining appropriations had been that they might be the better enabled to keep up hospitality in their respective houses, and that they might relieve the poor. These duties however were so far neglected as to give rise to general discontent; in addition to which, the officiating priests were very poorly paid, and oppressed with hard service, and consequently unable to answer the calls of hospitality and charity. At length the legislature, by way of a partial remedy to these evils, enacted (15 Richard II. c. 6), "That in every licence for the appropriation of a parish church, it should be expressed that the diocesan bishop should ordain, in proportion to the value of the church, a competent sum to be distributed among the poor parishioners annually, and that the vicarage should be sufficiently endowed." Still, as the vicar was removable at pleasure, he was not likely to insist too strictly on the legal sufficiency of the endowment. Therefore, to establish the total independence of vicars of the appropriators, the statute 4 Henry IV. c. 12, provided, "That from thenceforth in every church appropriated there should be a secular person ordained vicar perpetual, canonically instituted and inducted, and convenably (fitly) endowed by the discretion of the ordinary, to do divine service, and to inform the people, and to keep hospitality there; and that no religious, that is, regular priest, should in anywise be made vicar in any church appropriated." From the endowments made in pursuance of this statute have arisen all the vicarages that exist at the present day. The title of the vicar to tithes and other ecclesiastical dues, such as Easter offerings (which are said to be due to the parson or vicar of common right), and customary payments for marriages, burials, and baptisms, depends primarily upon the deed of endowment. As however the rector and vicar are persons equally capable in law of holding such property, the deed is not always conclusive evidence in any question that may arise between these parties as to their respective rights; but it is said, that where either of them has for a long time had undisputed enjoyment of any particular portion of the tithes or other fruits of the benefice, which is not consistent with the terms of the original deed, a variation of that deed by some subsequent instrument may be presumed in favour of such long enjoyment. The endowments of vicarages have generally consisted of a part of the glebe-land of the parsonage, and what are technically called the small tithes of the parish. In some places, also, a portion of the great tithes has been added to the vicarages. [Tithes.]

A vicarage by endowment becomes a distinct benefice, of which the patronage is vested in the impropriator or sinecure rector, and is said to be appendant to the rectory. It follows that the vicar, being endowed with separate revenues, is enabled to recover his temporal rights without the aid of the patron. The loss of the original Act of Endowment is supplied by prescription; that is, if the vicar has enjoyed any particular tithes or other fruits by constant usage, the law will presume that he was legally endowed with them.

If the impropriator, either by design or mistake, presents the vicar to the parsonage, the vicarage will be dissolved, and the person presented will be entitled to all the ecclesiastical dues as rector. [Vicarage.]

It is to be observed, that the statute 4 Henry IV. c. 12, did not extend to appropriations made before the first of Richard II. Hence it happens that in some appropriated churches no vicar has ever been endowed. In this case the officiating minister is appointed by the

impropriator, and is called a perpetual curate. He enters upon his official duties by virtue of the bishop's licence only, without institution or induction. It appears, moreover, that there were some benefices which, being granted for the purpose of supporting the hospitality of the monasteries (*in mensas monachorum*), and not appropriated in the common form, escaped the operation of the statute of Henry IV. In this case, the benefices were served by temporary curates belonging to the religious houses, and sent out as occasion required. When such appropriations, together with the charge of providing for the cure, were transferred (after the dissolution of monasteries) from spiritual societies to single lay persons (who, being incapable of serving them themselves, were obliged to nominate a person to the bishop for his licence to serve the cure), the curate by this means became so far perpetual as not to be removable at the pleasure of the impropriator, but only for such causes as would occasion the depriving of a rector or vicar, or by the revocation of the bishop's licence. Though the form of licences to perpetual cures expresses that they last only during the bishop's pleasure, the power of revocation, thus reserved to the bishop, has seldom, if ever, been exercised.

There is another kind of perpetual curacy which arises from the erection in a parish of a chapel of ease subject to the mother church. But the curacies of chapels of ease are not benefices in the strict legal sense of the word, unless they have been augmented out of the fund called Queen Anne's Bounty. The officiating ministers are not corporations in law with perpetuity of succession, as parsons, vicars, and other perpetual curates. Neither are chapels of ease subject to lapse, although the bishop may, by process in the ecclesiastical courts, compel the patrons to fill them up. But the statute 1 Geo. I. sess. 2, c. 10, provides that all churches, curacies, or chapels, which shall be augmented by the governors of Queen Anne's Bounty, shall be thenceforth perpetual cures and benefices, and the ministers duly nominated and licensed thereunto shall be in law bodies politic and corporate, and have perpetual succession, and be capable to take in perpetuity; and that if suffered to remain void for six months they shall lapse in like manner as presentative livings. [CHAPEL; CURATE.]

The district churches built in pursuance of the Church Building Acts, which form an almost unbroken series of statutes from 58 Geo. III. c. 45 to the present day, are perpetual cures, and the incumbents corporations.

A donative is a spiritual preferment, whether church, chapel, or vicarage, which is in the free gift of the patron, without making any presentation to the bishop, and without admission, institution, or induction by mandate from the bishop or any other; but the donee may by the patron, or by any other authorised by the patron, be put into possession. Nor is any licence from the bishop necessary to perfect the donee's title to possession of the donative, but it receives its full effect from the single act and sole authority of the donor. The chief further peculiarity of donatives is their exemption from episcopal jurisdiction. The visitation of donatives is by commissioners appointed by the patron. If the patron dies during the vacancy of a donative benefice, the right of nomination descends to his heir-at-law, and does not belong to his executors, as is the case with the patronge of presentative livings. Donatives, if augmented by Queen Anne's Bounty, become liable to lapse, and also to episcopal visitation. (1 Geo. I. sess. 2, c. 10.) But no donatives can be so augmented without the consent of the patron in writing, under his hand and seal. Both perpetual curates and incumbents of donatives are obliged to declare their assent to the Thirty-nine Articles and the Book of Common Prayer, and must take the oath of allegiance; and the right of patronage, both of perpetual curacies and donatives, is vindicated by writ of *Quare Impedit*.

Neither the augmentation nor the alienation of benefices with cure of souls has ever been favoured by the policy of the English law. To prevent the former was one of the objects of the statutes of Mortmain, one of which (23 Hen. VIII. c. 10) expressly makes void all assurances of lands in favour of parish churches, chapels, &c. [MORTMAIN.]

It might have been reasonably expected that, at the time of the dissolution of monasteries, the clergy would have received back those revenues which, being originally vested in them for religious purposes, had been subsequently appropriated by the monks. Such a measure, however, was not agreeable to the temper either of Henry VIII., or of his ministers and courtiers. When he came to a rupture with the pope, he resolved to free his dominions from the payment of first fruits and tenths to the papal treasury. The first of these taxes consisted of one year's whole profits of every spiritual preferment, according to a valuation of benefices made by the pope's authority; the second, of the tenth part of the annual profit of each benefice, according to the same valuation. The payment of these to the pope was prohibited by statute 25 Henry VIII. c. 20; but the impost was not abolished, for the next year by statute 26 Henry VIII. c. 3, the whole of the revenue arising therefrom was annexed to the crown. The last-mentioned statute directed these taxes to be paid according to a new valuation of ecclesiastical benefices to be made by certain commissioners appointed for the purpose. This valuation is what is still called the valuation of the king's books. The statute 26 Henry VIII. c. 3, was confirmed by statute 1 Eliz. c. 4. [FIRST FRUITS.]

The subsequent proceedings of Henry VIII., after the appropriation of the possessions of the monasteries, tended rather to enrich the

collegiate and other corporations aggregate with the revenues of the Church, than to revest them in their ancient possessors. Nor was the latter object the aim of his successors, until more than a century after his death; but after the restoration of Charles II., the scandal of lay impropriations gave rise to some relaxation of the statutes of mortmain. Thus by statute 17 Car. II. c. 3, power was given to lay impropriators of tithes to annex such tithes to, or settle them in trust for, the parsonage or vicarage of the parish church to which they belonged, or for the perpetual curate, if there was no vicarage endowed; and by the same statute, in cases where the settled maintenance of the parsonage or vicarage, with cure, did not amount to the full sum of 100*l.* a-year, clear of all charges and reprizes, the incumbent was empowered to purchase for himself and his successors, lands and tithes, without licence of mortmain. Another statute of the same reign (29 Car. II. c. 8) confirms, for a perpetuity, such augmentations of vicarages and perpetual curacies as had been already made for a term of years by ecclesiastical corporations, on granting leases of impropriate rectories. The Act also confirms future augmentations to be made in the same manner, subject to a limitation which has since been taken off by statute 1 & 2 Will. IV. c. 45, by which the provisions of 29 Car. II. c. 8 have been considerably extended. But the principal augmentation of the revenues of the Church was made under the provisions of the statute 2 & 3 Anne, c. 11. By this Act, and by the queen's letters-patent made in pursuance of it, all the revenue of the first fruits and tenths was vested in trustees, for the augmentation of small benefices. This fund is what is usually called Queen Anne's Bounty, the administration of which has been regulated by several statutes.

The trustees, who are certain dignitaries of the Church, and other official personages for the time being, are incorporated by the name of "the governors of the Bounty of Queen Anne, for the augmentation of the maintenance of the poor clergy," and have authority to make rules for the distribution of the fund, which rules are to be approved of by the crown under the sign manual. Every person having any estate or interest in possession, reversion, or contingency, in lands or personalty, is empowered to settle such estate or interest, either by deed enrolled or will, upon the corporation, without licence of mortmain; and the corporation are empowered to admit benefactors to the fund into their body. Agreements made with benefactors to Queen Anne's Bounty, concerning the right of patronage of augmented churches in favour of such benefactors, where the agreements are made by persons or bodies corporate having such an interest in the patronage of such churches as the Act renders necessary are made valid; but an agreement by a parson or vicar must be made with consent of his patron and ordinary. The governors are also empowered by the same statute to make agreements with patrons of donatives or perpetual cures for an augmented stipend to the ministers of such benefices when augmented, to augment vacant benefices, and with the concurrence of the proper parties, to exchange lands settled for augmentation.

It should be observed that a modern statute of mortmain, the Statute of Charitable Uses, 9 Geo. II. c. 36, imposed certain forms, a strict compliance with which was necessary in all gifts to Queen Anne's Bounty, whether by deed or will. But these restrictions have been removed by statute 43 Geo. III. c. 107, as far as respects gifts of real property for augmentation of the bounty; and a recent provision for the augmentation of benefices not exceeding 150*l.* per annum is made by 46 Geo. III. c. 133, which discharges all such benefices from the land-tax, without any consideration being given for the discharge, with a proviso that the whole annual amount thus remitted shall not exceed 6000*l.*

The alienation of the temporalities of benefices, even in perpetuity, was not forbidden by the common law, provided it were made with the concurrence of the principal parties interested, namely, the parson, patron, and ordinary. Thus, at the common law, lands might have become exempt from the payment of tithe by virtue of an agreement entered into between the tithe-payer and the parson or vicar, with the necessary consent, for the substitution of land in lieu of tithe. But the statute 13 Eliz. c. 10 prohibits, among other bodies corporate, parsons and vicars from making any alienation of their temporalities beyond the life of the incumbent, except by way of lease for twenty-one years, or three lives, "whereupon the accustomed yearly rent or more shall be reserved and payable yearly during the said term." Further restrictions are imposed by the statute 18 Eliz. c. 11, which requires that where any former lease for years is in being, it must be expired, surrendered, or ended within three years next after the making of the new lease, and all bonds and covenants for renewing or making leases contrary to this and the last-mentioned statute are made void. The statute 14 Eliz. c. 11, as to houses in towns, extends the term specified in the 13 Eliz. c. 10 to forty years, but prohibits leases of such houses in reversion, and allows of absolute alienation by way of exchange. But the consent of patron and ordinary is still necessary in order to make the leases of parsons and vicars binding upon their successors. It is said that about the time when these statutes were passed, it was a practice for patrons to present unworthy clergymen to their vacant benefices, on condition of having leases of those benefices made to themselves at a very low rate. The consequences of this were not unlike what ensued from the appropriation of benefices by monastic corporations; the incumbents did not reside, and the churches were indifferently served by stipendiary curates. To remedy this evil,

it was provided by statute 13 Eliz. c. 20 (made perpetual by 3 Car. I. c. 4), that no lease of a benefice with cure should endure longer than while the lessee should be ordinarily resident and serving the cure, without absence for more than eighty days in any one year, but should immediately, upon non-residence, become void; and that the incumbent should forfeit one year's profits of the benefice, to be distributed among the poor; but the statute contains an exception of the case where a parson, allowed by law to have two benefices, demises the one, upon which he is not most ordinarily resident, to his curate. The 18 Eliz. c. 11, provides that process of sequestration shall be granted by the ordinary to obtain the profits so forfeited. By statute 14 Eliz. c. 11, bonds and covenants, and by statute 43 Eliz. c. 9, judgments entered into or suffered in fraud of the statute 13 Eliz. c. 20, are made void.

The 13 Eliz. c. 20, also renders void all charges upon ecclesiastical benefices by way of pension or otherwise. This last provision has been held to extend to mortgages and annuities, even if made only for the life or incumbency of the mortgager. But the strictness of the laws prohibiting all alienations by or in favour of ecclesiastical persons, has in modern times been somewhat relaxed by the legislature for purposes of public convenience, such as the General Inclosure Acts. Other statutes empower ecclesiastical incumbents, with consent of patron and ordinary, to raise money by sale or mortgage of the profits of the benefice, for a term, for the purpose of building and repairing parsonage houses; and the governors of Queen Anne's Bounty are permitted to advance money for the same object. Incumbents, with consent of patron and ordinary, may exchange their parsonage houses and glebe lands, and purchase and annex to their benefice other parsonage houses and glebe lands. Rectors and vicars are also enabled to charge their benefices in favour of chapels of ease within their cures.

Although an ecclesiastical benefice cannot be alienated for the satisfaction of the incumbent's debts, the profits may be sequestrated for that purpose. [SEQUESTRATION.]

The duties and liabilities of spiritual persons come more properly under the head of CLERGY, but it is not inconsistent with the subject of the present article to mention the non-residence of spiritual persons upon their benefices, which (besides being cognisable in the ecclesiastical courts) is visited with severe penalties by different acts of parliament. The principal of the old enactments on the subject is stat. 21 Hen. VIII. c. 13 (amended and enlarged by 25 Hen. VIII. c. 16, 28 Hen. VIII. c. 13, and 33 Hen. VIII. c. 28), which imposes certain penalties upon persons wilfully absenting themselves from their benefices for one month together, or two months in the year.

But this act excepts the chaplains to the king and royal family, those of peers, peeresses, and certain public officers, during their attendance upon the household of such as retain them; and also all heads of colleges, magistrates, and professors in the universities, and all students under a certain age residing there *bonâ fide* for study. And the king may grant dispensations for non-residence to his chaplains, even when they are not attending his household. The residence intended by the law must be in the parsonage house, if there be one; but if there be no house of residence, the incumbent must reside within the limits of the benefice, or of the city, town, or parish where the benefice is situate, provided such residence be within two miles from the church or chapel of the benefice; and in all such cases a residence may be appointed by the bishop, even without the limits of the benefice. These acts (which extend also to archdeaconries, deaneries, and dignities in cathedral and collegiate churches) have been consolidated and amended by stat. 57 Geo. III. c. 99. By this act, every incumbent absenting himself from a benefice with cure, without licence, for the period of three months consecutively, or at several times for so many days as are equal to this period, and abiding elsewhere than at some other benefice, forfeits for an absence exceeding three months, but not above six months, one-third of the annual value of the benefice, clear of all outgoings except the curate's salary. Absences of a longer duration are subjected to proportional penalties, and the whole of the penalty in each case is given to the party suing, together with such costs as are allowed by the practice of the court where the action is brought. All who were exempt from residence before the last statute are still exempt, and the exemption is extended to several others, including public officers in either of the two universities, and tutors and public officers in any college. Students in the university are exempted till they are thirty years of age; and the royal prerogative to grant dispensations for non-residence to his chaplains is not affected by the statute. But no person can have the benefit of an exemption unless he makes a notification of it every year, within six weeks from the 1st of January, to the bishop of the diocese. Besides the exemptions, the bishop may grant a licence for non-residence for the illness or infirmity of an incumbent, his wife, or child, or for other causes specified in the Act; and if the bishop refuses a licence, the incumbent may appeal to the archbishop. The bishop may also grant licences for non-residence for causes not specified in the Act, but in that case the licences must be allowed by the archbishop. Licences may be revoked, and no licence can continue in force above three years from the time of its being granted, or after the 31st of December in the second year after that in which it is granted. The Act also contains directions with respect to the lists of exemptions and licences for non-residence, which are to be kept in the registry of each diocese for public inspection.

The Act 57 Geo. III. c. 99 provides also for the appointment of licensed curates in benefices, the incumbents of which are absent with or without licence or exemption, and regulates the salaries of such curates upon a scale proportioned to the value of each benefice and the number of the population within its precincts; and in all cases of non-residence from sickness, age, or other unavoidable cause, the bishop may fix smaller salaries at his discretion.

There are other liabilities which parsons, vicars, and other spiritual persons necessarily incur in respect of their benefices. Thus, by 43 Eliz. c. 2, they are rateable in respect of their benefices for the relief of the poor; and although the burden of the repairs of the body of the church falls upon the parishioners, the rector (and, where the parsonage is appropriated, the impropriator) is liable for the repairs of the chancel. And the stat. 35 Ed. I. sess. 2, the object of which was to prohibit rectors from cutting down trees in churchyards, contains an express exception of the case where such trees are wanted for the repair of the chancel.

Besides the liability implied in the last-mentioned prohibition, all ecclesiastical incumbents are liable for dilapidations. A dilapidation is said to be the pulling down or destroying in any manner any of the houses or buildings belonging to a spiritual living, or suffering them to run into ruin or decay, or wasting or destroying the woods of the church, or committing or suffering any wilful waste in or upon the inheritance of the church. Such proceedings may be prevented by the spiritual censures of the ordinary; and the profits of the benefice may be sequestered until the damage be repaired; and the Court of Chancery will, at the suit of the patron, grant an injunction to restrain this as well as every other species of waste; or the next incumbent may recover damages for dilapidations either in the Spiritual Court or in an action at common law against his predecessor, or, if he be dead, against his personal representatives.

The remedies for the subtraction of tithes given by the law of England to the clergy are sufficiently ample. The stat. 2 & 3 Ed. VI. enables them to recover the tithes in the Spiritual Courts; while modern statutes, and particularly 53 Geo. III. c. 127, and 7 Geo. IV. c. 15, have given a summary remedy for the recovery of tithes under a certain amount before two justices of the peace, who are empowered to levy them by distress. But questions of title to tithes belong to the temporal courts only, a subject which will be more properly considered under the head of TITHES.

With respect to actions and suits for recovery of lands or rents by parsons, vicars, or other spiritual corporations sole, the stat. 3 & 4 Will. IV. c. 27 subjects them to the period of limitation of two successive incumbencies, together with six years after the appointment of a third person to the benefice, or in case of this period not amounting to sixty years, then to the full period of limitation of sixty years.

Having thus shown how possession of the different kinds of benefices in England is acquired and maintained, and what are the principal legal incidents of such possession, it remains to consider how benefices may be vacated or avoided. And this may happen several ways: 1. By the death of the incumbent. 2. By resignation, which is made into the hands of the ordinary, except in the case of donatives, which must be resigned into the hands of the patron, who alone has jurisdiction over them. The resignation must be absolute, unless it be for the purpose of exchange, in which case it may be made on the condition that the exchange shall take full effect. Where two parsons wish to exchange benefices, they must obtain a licence from the ordinary to that effect; and if the exchange is not fully executed by both parties during their lives, all the proceedings are void. 3. A benefice may be avoided by the incumbent's being promoted to a bishopric; but the avoidance in this case does not take place till the actual consecration of the new prelate. The patronage of the benefice so vacant belongs for that turn to the crown, except in the case of a clergyman, beneficed in England, accepting an Irish bishopric; for no person can accept a dignity or benefice in Ireland until he has first resigned all his preferments in England; so that in this case the patron, and not the crown, has the benefit of the avoidance. If the incumbent of a donative be promoted to a bishopric, no cession takes place; and it seems that he may retain the donative without a commendam.

4. If an incumbent of a benefice with cure of souls accepts a second benefice of a like nature without procuring a dispensation, the first, by the provisions of the canon law, is so far void, that the patron may present another clerk, or the bishop may deprive; but till deprivation no advantage can be taken by lapse. And the stat. 21 Henry VIII. c. 13 provides, that where a person, having a benefice of the value of 8*l.* per annum or upwards, according to the valuation of the king's books, accepts any other, the first shall be adjudged void, unless he obtains a dispensation in conformity with the provisions of the statute. And dispensations not in conformity with the statute are declared void, and heavy penalties are imposed upon persons endeavouring to procure them. But by virtue of such dispensations, spiritual persons of the king's council may hold three benefices with cure, and the other persons qualified by the statute to receive dispensations may each hold two such benefices. The statutes 1 & 2 Vict. c. 106, amended by 13 & 14 Vict. c. 98, have however provided that two benefices cannot be held by the same person, unless they be within three miles of each other, and the value of one does not exceed 100*l.*

The persons who may receive dispensations are the king's chaplains,

those of the queen and royal family, and other persons who are allowed by the statute to retain a certain number of chaplains, and also the brethren and sons of all temporal lords, the brethren and sons of knights, and all doctors and bachelors of divinity and law, admitted to their degrees in due form by the universities. The privilege is not extended to the brethren and sons of baronets, as the rank of baronet did not exist at the time when the statute was passed. [CHAPLAIN.]

The statute expressly excepts deaneries, achdeaconries, chancellorships, treasurerships, chanterships, prebends, and sinecure rectories. Donatives are within the statute, if a donative is the first living; but if a donative is the second living taken without a dispensation, the first is not made void by the statute, the words of which are "instituted and inducted to any other," words not applicable to donatives. But it seems that both in the cases excepted by the statute, and in the case where the second living is a donative, a dispensation is equally necessary in order to hold both preferments, as otherwise the first would be voidable by the canon law.

The stat. 36 Geo. III. c. 83 has brought chapels and churches, augmented by Queen Anne's bounty, within the Statute of Pluralities, by enacting that such churches and chapels shall be considered as presentative benefices, and that the licence to serve them shall render other livings voidable in the same manner as institution to presentative benefices. It appears that both by the common law, and by the provisions of stat. 37 Hen. VIII. c. 21, and 17 Car. II. c. 3, a union or consolidation of two benefices into one might with consent of patrons, ordinaries, and incumbents, be made in such a manner as not to be affected by the Statute of Pluralities.

For the manner of obtaining dispensations from the archbishop, and for the form of such dispensations, and the confirmation thereof by the lord chancellor, and the provisions which the canon law requires to be inserted in such dispensations, see Burn's 'Eccles. Law,' title 'Plurality.'

5. Another mode of avoidance of a benefice, is by deprivation under a sentence of an ecclesiastical court. The principal causes on which sentence of deprivation is usually founded, are heresy, blasphemy, gross immorality; or conviction of treason, murder, or felony.

6. A benefice may be avoided by act of the law; as where the incumbent omits or refuses to subscribe the Thirty-Nine Articles, or declaration of conformity to the Liturgy, or to read the Articles or Book of Common Prayer, in pursuance of the statutes which render those acts necessary. But the most remarkable mode of avoidance which is to be classed under this head, is that for simony, in pursuance of the stat. 31 Eliz. c. 6. By this statute for the avoiding of simony, it is among other things enacted, that if any patron, for any sum of money, reward, profit, or benefit, or for any promise, agreement, grant, bond, of or for any sum of money, reward, gift, profit, or benefit, shall present or collate any person to an ecclesiastical benefice with cure of souls or dignity, such presentation or collation shall be utterly void, and the crown shall present to the benefice for that turn only. The statute also imposes a penalty upon the parties to the simoniacal contract to the amount of double the value of a year's profit of the benefice, and for ever disables the person corruptly procuring or accepting the benefice from enjoying the same. And by stat. 12 Anne, sess. 2. c. 12, a purchase by a clergyman, either in his own name or that of another, of the next presentation *for himself*, is declared to be simony, and is attended with the same penalties and forfeiture as are imposed by the statute of Elizabeth. Upon the construction of this statute of Elizabeth it has been held, that if the next presentation can be shown to have been purchased with the intention of presenting a particular person, who, upon a vacancy taking place, is presented accordingly, this fact is sufficient to render the transaction simoniacal. An exception has however been made in the case of a father providing for his son by the purchase of a next presentation, but the principle of this exception has lately been denied.

The circumstance of the incumbent being at the point of death at the time of the contract, may also vitiate the transaction: except where the fee simple of the advowson is purchased, in which case it has been decided that the knowledge of the state of the incumbent's health does not make the purchase simoniacal.

It has been a question much agitated in our courts, whether a presentation is valid where the person presented enters into a bond or agreement, either generally to resign the benefice at the patron's request, or to resign it in favour of a particular person specified in the instrument. After several contrary decisions in the courts below, it was finally decided by the House of Lords towards the latter end of the last century, that general bonds of resignation were simoniacal and illegal. A similar decision has since been made by the same tribunal with respect to bonds of resignation in favour of specified persons. As there is no objection on the grounds of public policy to the last-mentioned instruments, if restrained within due limits, the interference of the legislature has been thought necessary in order to regulate transactions of this nature. On this account, after a retrospective Act (7 & 8 Geo. IV. c. 25) had been passed, to remedy the hardships that might otherwise have been occasioned by the last-mentioned judgment of the House of Lords, it was finally enacted by the 9 Geo. IV. c. 94, that every engagement, *bonâ fide* made for the resignation of any spiritual office or living, in favour of a person, or one of two persons to be specially named therein, being such persons as were mentioned

in a subsequent section of the Act, should be valid and effectual in the law, provided such engagement were entered into before the presentation of the party entering into the same. By the section referred to, where two persons are specially named in the engagement, each of them must be, either by blood or marriage, an uncle, son, grandson, brother, nephew, or grandnephew of the patron (provided the patron is not a mere trustee), or of the person for whom the patron is a trustee, or of the person by whose direction the presentation is intended to be made, or of any married woman whose husband in her right is patron, or of any other person in whose right the presentation is intended to be made. The deed containing the engagement to resign must be deposited for inspection with the registrar of the diocese wherein the benefice is situated, and every resignation made in pursuance of such an engagement must refer to the same, and state the name of the person for whose benefit it is made and becomes void, unless that person is presented within six months. The statute is limited in its operation to cases where the patronage is strictly private property.

There are certain benefices of which the patronage is either by custom or act of parliament vested in certain public officers or corporations. Thus, the lord chancellor has the absolute patronage of all the king's livings which are valued at 20*l.* per annum or under in the king's books. It is not known how this patronage of the chancellor was derived; but it appears from the rolls of parliament in the 4th Ed. III., that the chancellor at that time had the patronage of all the king's livings of the value of 20 marks or under, and it is not improbable that at the time of making the new valuation of benefices in the reign of Henry VIII., a new grant was made to the chancellor by the crown, in consideration of the altered value of ecclesiastical property. By stat. 3 James I. c. 5, popish recusants are disabled from exercising any right of ecclesiastical patronage; and the patronage of livings in the gift of such persons is vested in the two universities, according to the several counties in which the livings are situate. This disability was confirmed by the subsequent statutes 1 Will. & Mary, c. 26, 12 Anne, sess. 2 c. 14, and extended to cases where the right of patronage was vested in a trustee for a papist; and is not removed (along with the other disabilities affecting Roman Catholics) by stat. 10 Geo. IV. c. 7. But the last-mentioned act provides, that where any ecclesiastical patronage is connected with any office in the gift of the crown, which office is held by a Roman Catholic, the patronage, so long as the office is so held, shall be exercised by the Archbishop of Canterbury.

The Church of Ireland being the same with that of England, the ecclesiastical polity of each is in its main principles the same. The same law of ecclesiastical patronage, the same classification of benefices, the same circumstances of lay impropriations, and, in short, the same ecclesiastical privileges and disabilities may prevail in each country. But a most important alteration in the distribution of the revenues of the Irish Church was effected by the 3 & 4 Will. IV. c. 37, amended by 4 & 5 Will. IV. c. 90. By this Act, certain ecclesiastical commissioners are established as a corporation, for the augmenting of small livings out of the funds, which come into their hands by virtue of the Act, and for other ecclesiastical purposes. The funds in question arise, partly from the revenues of certain bishoprics which are abolished, and the surplus revenues of the rest above certain limits fixed by the Act; partly from the money paid by the tenants of lands held under bishops' leases renewable for ever, for a conversion of such leasehold interest into a perpetuity; and partly from a tax levied on all ecclesiastical dignities and benefices, according to a scale of taxation specified in a schedule to the Act; in consideration of which tax all first fruits are abolished. The commissioners are invested with extraordinary powers by the Act. Thus, they have authority to disappropriate benefices united to dignities, and to unite them to vicarages in lieu thereof. They have also the power of suspending the appointment to benefices which are in the gift either of the crown, of archbishops, bishops, or other dignitaries, or of ecclesiastical corporations, where it appears that divine service has not been performed within such benefices for three years before the passing of the Act. The subject of the better regulation of the revenues and discipline of the Irish Church occasionally engages the attention of the legislature.

We have mentioned the attempts of the popes to acquire the right of patronage to all ecclesiastical benefices in Europe, and the successful measures that were taken in England for resisting their pretensions. After ineffectual attempts had been made at the councils of Constance and Basle, in 1414 and 1433, to check the papal encroachments, each of the principal European governments seems to have asserted in some measure its own ecclesiastical independence, either by entering into concordats with the pope, or assuming the right of controlling his pretensions by national legislation. The latter course seems to have been adopted by Spain towards the end of the 15th century. (Hallam's 'Middle Ages,' vol. ii. p. 361.) The emperor of Germany in 1448 entered into a concordat at Aschaffenburg with the pope, which is said to be still the law of the Catholic states of Germany. By this treaty, the pope obtained the right of collation to all benefices that fell vacant during six alternate months of the year. By the Pragmatic Sanction of Charles VII. of France, published in 1438, all mandates and reservations with respect to benefices in that country were abolished for the future. This ordinance was followed, in the beginning of the 16th century, by the concordat of Francis I. and Leo X., which remained till the time of

the French revolution a fundamental law of the Gallican Church. By this treaty the pope gave up his indefinite claims to the patronage of benefices, and received a small stipulated patronage in return; and the substantial part of the patronage of bishoprics was vested in the crown. The modern concordat of Pius VII. with Napoleon, though destructive of the liberties of the Gallican Church, does not appear, so far as respects the right of the pope to interfere with the patronage of benefices, to be a material innovation upon the concordat of Francis I. [CONCORDAT.]

For the numerous abuses with respect to the patronage, acquisition, and transmission of benefices that prevailed in the Roman Catholic Church, especially in Italy, during the 15th and 16th centuries, see Father Paul's 'Treatise on Benefices,' cap. 44–46.

BENEFI'CIUM, a Latin word, literally, "a good deed;" also "a favour," "an act of kindness." ('Seneca de Beneficiis,' l. iii. c. 18.) This word had several technical significations among the Romans.

When a proconsul, proprætor, or quæstor, returned to Rome from his province, he first gave in his accounts to the treasury; after which he might also give in the names of such persons as had served under him in the province, and by their conduct had deserved well of the state. To do this was expressed by the phrase, "in beneficiis ad ærarium deferre,"—"to give into the treasury the names of deserving persons;" and in the case of certain officers and persons, this was to be done within thirty days after the proconsul, &c., had given in his accounts. The object of this practice was apparently to recommend such individuals to public notice and attention, and in many cases it would be a kind of introduction to future honours and emoluments. It does not seem quite certain if money was given to those thus recommended in the time of Cicero (Cicero, 'ad Divers.' V. 20. 'Pro Archia,' 5.) Beneficium, in another sense, means some honour, promotion, or exemption from certain kinds of service, granted by a Roman governor or commander to certain of his soldiers, hence called Beneficiarii. (Cæsar, 'de Bello Civili,' i. 75, iii. 88; Sueton. 'Tiber.' 12; Festus sub verb. 'Beneficiarii.') Numerous inscriptions given in Gruter, show how common this practice was: in some of them the title is represented by the initial letters B. F., only; Beneficiarius Legati Consularis (li. 4); B. F. Proconsulis (cxxx. 5), &c. Under the emperors, beneficia appear to have signified any kind of favours, privileges, or emoluments granted to a subject by the sovereign; and Suetonius observes ('Titus,' 8) that all the Cæsars, in conformity with a regulation of Tiberius, considered that, on their accession to the supreme power, all the grants (beneficia) of their predecessors required confirmation, but Titus by one edict, without solicitation, confirmed all grants of previous emperors. The grants made by the emperors, which were often lands, were entered in a book called the Liber Beneficiorum, which was kept by the chief clerk of benefices, under the care of the Comes Rerum Privatarum of the emperor; or it was kept by a person entitled "A Commentariis Beneficiorum," or clerk of the benefices, as we learn from a curious inscription in Gruter (DLXXVIII. 1). This, which is a monumental inscription, is in memory of M. Ulpius Phædimus, who among other offices held that of clerk of benefices to Trajan: the monument was erected in the reign of Hadrian, A.D. 131, by Valens Phædimianus, probably one of the same family, who styles himself wardrobe-keeper (a veste).

Beneficium, in the civil law, signifies any particular privilege: thus it is said ('Dig.' i. 4. 3.) that the beneficium of the emperor must be interpreted very liberally; and by the Julian law, *de bonis cedendis*, a debtor was said to receive the benefit (beneficium) of not being taken to prison. (C. vii. 71, 1.)

Beneficium, among the writers of the middle ages, signified any grant of land from the fiscus, that is, the private possessions of the king or sovereign, or any other person, for life; so called, says Ducange, because it was given out of the mere good will (beneficium) and that liberality of the grantor. But it is evident, from what we have said, this kind of grant was called beneficium after the fashion of the grants of the Roman emperors; a view which has been supported directly by Palgrave ('Rise and Progress of the British Constitution,' vol. i. p. 356) and indirectly by Hallam, who, in the first volume of 'The History of Europe during the Middle Ages,' c. ii., has controverted with great force and learning the position of nearly all the old writers on the feudal system, that benefices were originally precarious and revoked at pleasure by the sovereign. A beneficiary grant in the middle ages appears to have been properly a grant for life, that is, a grant to the individual, and accordingly corresponds to *usufructus*, and is opposed to *proprietas*. The name beneficium, as applied to a feudal grant, was afterwards changed for that of feudum; and the terms beneficium and feudum are often used indifferently in writings which treat of feuds [FEUD]. For further remarks on the term beneficium, see Ducange. 'Glossarium,' &c.; Hotman, 'Commentarius Verborum Juris, Opera.' Lugd. fol. 1599: and Spelman 'on Feuds,' c. iii.

BENEFIT OF CLERGY. The privilege or exemption thus called had its origin in the regard which was paid by the various sovereigns of Europe to the early Christian Church, and in the endeavours of the popes to withdraw the clergy altogether from secular jurisdiction. In England, these attempts, being vigorously resisted by our earlier kings after the Conquest, only succeeded partially and in two particular instances: namely, in procuring, 1. the exemption of places consecrated to religious purposes from arrests for crimes, which was the origin of sanctuaries [SANCTUARY]; and, 2. the exemption of clergymen in certain cases from criminal punishment by secular judges. From the latter exemption came the benefit of clergy, which arose when a person indicted for certain offences pleaded that he was a clerk or clergyman, and claimed his *privilegium clericale*. Upon this plea and claim the ordinary appeared and demanded him; a jury was then summoned to inquire into the truth of the charge, and according to their verdict the accused was delivered to the ordinary, either as *acquit* or *convict*, to undergo canonical purgation, and then to be discharged or punished according to the result of the purgation. This privilege, however, never extended to high treason nor to offences not capital, and wherein the punishment would not affect the life or limb of the offender (*quæ non tangunt vitam et membrum*). It is singular that before the stat. 3 & 4 Will. III., which expressly includes them, this privilege of clergy never extended by the English law to women, although, by the canon law, nuns were exempted from temporal jurisdiction.

In the early period of our history, the benefit of clergy was not allowed, unless the prisoner appeared in his clerical habit and tonsure; but in process of time, as the original object of the privilege was gradually lost sight of, this ceremony was considered unnecessary, and the only proof of clergy required was his showing to the satisfaction of the court that he could read; a rare accomplishment, except among the clergy, previously to the 15th century. The consequence was, that at length all persons who could read, whether clergymen or lay clerks, as they were called in some ancient statutes, were admitted to the benefit of clergy in all prosecutions for offences to which the privilege extended. The mode in which this test of reading was applied is thus described by Sir Thomas Smith, in his 'Commonwealth of England,' written in 1565. "The bishop," says he, "must send one with authority under his seal to be a judge in that matter at every gaol delivery. If the condemned man demandeth to be admitted to his book, the judge commonly giveth him a Psalter, and turneth to what place he will. The prisoner readeth so well as he can (God knoweth sometime very slenderly), then he (the judge) asketh of the bishop's commissary, *Legit ut clericus?* The commissary must say *legit* or *non legit*, for these be words formal, and our men of law be very precise in their words formal. If he say *legit*, the judge proceedeth no further to sentence of death; if he say *non*, the judge forthwith proceedeth to sentence."

The clergy, however, do not appear to have universally admitted that the mere fact of a prisoner's ability to read was to be taken as a conclusive proof of his clerical character. A curious case is recorded in the 'Year Book,' 34 Hen. VI. 49 (1455), which greatly puzzled the judges: A man indicted of felony claimed the benefit of clergy; upon which the archdeacon of Westminster Abbey was sent for, who showed him a book, in which the felon read well and fluently. Upon hearing this, the court ordered him to be delivered to the archdeacon on behalf of the ordinary; but the archdeacon refused to take him, alleging that the prisoner was not a clerk. This raised a serious difficulty; and the question was one of particular importance to the prisoner, as the judges deliberated whether he must not of necessity be hanged. He was, however, remanded to prison, and the subject was much discussed by the judges for several terms; but, luckily for the culprit, the conscientious archdeacon being removed, his successor heard the prisoner read, and consented to receive him; whereupon he was delivered to the ordinary, the judges saying "that *in favorem vitæ et libertatis ecclesiæ*, even where a man had once failed to read, and had received sentence of death, they would allow him his benefit of clergy, under the gallows, if he could then read, and was received by the ordinary." Another case is recorded in the 21 Edw. IV. (1481), in which a felon read well and audibly in the presence of the whole court; but the ordinary declared "*non legit ut clericus* for divers considerations:" upon which judgment was given that he should be hanged; "And so," says the reporter, "he was, *ut audivi*." ('Year Book,' 21 Edw. IV. 21.) But though a felon might claim the benefit of clergy to the last moment of his life, it was an indictable offence to teach him to read for the purpose of saving him. Thus in the 7 Ric. II. (1383), the vicar of Round Church in Canterbury was arraigned and tried, "for that by the license of the jailer there, he had instructed in reading one William Gore, an approver, who at the time of his apprehension was unlearned" (*ineruditus in lecturâ*). (Dyer's 'Reports,' p. 206.) It may readily be conceived that questions between the temporal courts and the ordinary would arise as the art of reading became more generally diffused; and it was probably on this account that an express provision was made by the legislature, in order in some degree to obviate the occurrence of such difficulties. The statute 4 Henry VII. c. 13 (1488), revived the distinction between actual clergymen and such persons as had accidentally acquired a competent skill in reading, by providing that no person once admitted to the benefit of clergy should a second time be allowed the same privilege, unless he produced his orders; and to mark those who had once claimed the privilege, the statute enacted that all persons, not in orders, to whom it was so allowed, should be marked upon the "brawn of the left thumb," in the court, before the judge, before such person was delivered to the ordinary. After the offender was thus burned in the hand, he was formally delivered to the ordinary to be dealt with according to the ecclesiastical canons, and to make purgation by undergoing the farce of a canonical trial. This second trial took place

before the bishop or his deputy; there was a jury of twelve persons, who gave their verdict on oath; witnesses were examined on oath; the prisoner answered on oath; and twelve compurgators swore that they believed him. On this occasion, though the prisoner had been convicted at common law by the clearest evidence, or had even confessed his guilt, he was almost invariably acquitted. The whole proceeding before the ordinary is characterised by Chief Justice Hobart at the beginning of the 17th century, "as turning the solemn trial of truth by oath into a ceremonious and formal lye." (Hobart's 'Reports,' p. 291.) To remove this discreditable abuse of the forms of justice, the statute 18 Eliz. c. 7, enacted, that in all cases after an offender had been allowed his clergy, he should not be delivered to the ordinary, but be at once discharged by the court, with a provision that he might be detained in prison for any time not exceeding a year, at the discretion of the judge before whom he was tried.

By various statutes passed in the course of the last century, the court before which an offender was tried and admitted to his clergy were empowered to commute the burning in the hand for transportation, imprisonment, or whipping; and subsequently to the passing of these statutes it is believed that no instance has occurred of a convict being burned in the hand.

The practice of calling upon a convicted person to read in order to prove to the court his title to the benefit of clergy continued until a comparatively late period. A case is mentioned in Kelynge's 'Reports,' p. 51, which occurred in 1666, where the bishop's commissary had deceived the court by reporting, contrary to the fact, that a prisoner could read; upon which Chief Justice Kelynge rebuked him severely, telling him "that he had unpreached more that day than he could preach up again in many days," and fined him five marks. At length the statute of the 5th of Anne, c. 6, enacted that the benefit of clergy should be granted to all those who are entitled to it without requiring them to read; and thus the "idle ceremony of reading," as Mr. Justice Foster justly terms it, was finally abolished. Till comparatively recently, every felon on conviction for a capital offence was accordingly told to go down on his knees and "pray his clergy," in the absence of which ceremony, it was supposed that the judge could not avoid passing sentence of death.

The absurd and perplexing distinctions which the continuance of this antiquated and worn-out clerical privilege had introduced, having become extremely detrimental to the due administration of justice, it was abolished by statute 7 & 8 Geo. IV., c. 28. Doubts having been raised, whether the provision of 1 Edw. IV., c. 2, retaining the benefit of clergy to lords of parliament and peers of the realm, might not still be in force, a subsequent statute put its entire abolition beyond question, 4 & 5 Vict. c. 22. The subject is now of no practical importance; but those who may be inclined to pursue it as a matter of historical curiosity may find the following references useful: Blackstone's 'Commentaries,' vol. iv. chap. 28; Hale's 'Pleas of the Crown,' part ii. c. 45; Barrington's 'Observations on Ancient Statutes;' Hobart's 'Reports,' p. 288.

BENEFIT SOCIETIES. [FRIENDLY SOCIETIES.]

BENEVOLENCE, a species of forced loan or gratuity, and one of the various arbitrary modes of obtaining supplies of money, which, in violation of Magna Charta, were formerly resorted to by the kings of England. The name implies a free contribution, with or without the condition of repayment; but so early as the reign of Edward IV. the practice had grown into an intolerable grievance. That king's lavish liberality and extravagance induced him to levy benevolences very frequently; and one of the wisest and most popular acts of his successor, Richard III., was to procure the passing of a statute (cap. 2) in the only parliament assembled during his reign, by which benevolences were declared to be illegal; they were denounced as "new and unlawful inventions," and as "the cause of great penury and wretchedness;" but this statute did not clearly forbid the solicitation of voluntary gifts, and Richard himself afterwards violated its provisions. Henry VII. exacted benevolences, which were enforced in a very oppressive way. Archbishop Morton, who solicited merchants and others to contribute, employed a piece of logic which obtained the name of "Morton's fork." He told those who lived handsomely, that their opulence was manifested by their expenditure; and those who lived economically, that their frugality must have made them rich; so that no class could evade him. Cardinal Wolsey, among some other daring projects to raise money for Henry VIII., proposed a benevolence, which the citizens of London objected to, alleging the statute of Richard III.; but the answer was, that the act of a usurper could not oblige a lawful sovereign. Elizabeth also "sent out her privy seals," for so the circulars demanding a benevolence were termed; but though individuals were committed to prison for refusing to contribute, she repaid the sums exacted. Lord Coke, in the reign of James I., is said to have at first declared that the king could not solicit a benevolence, and then to have retracted his opinion, and pronounced upon its legality.

The subject underwent a searching investigation during the reign of Charles I., as connected with the limitation of the king's prerogative. Writs were issued under the privy seal for the collection of a general loan from every individual, and the collectors had private instructions to require not less than a certain proportion of each man's property in land or goods, and had extraordinary powers given them, one being to

remove any person of station and local authority from the commission of the peace, if he enjoyed that dignity. The name of loan given to this tax was a fiction which the most ignorant could not but detect. Many of the common people were impressed to serve in the navy for refusing to pay: and a number of the gentry were imprisoned. The detention of five knights, who sued the Court of King's Bench for their writ of Habeas Corpus, gave rise to a most important question respecting the freedom of English subjects from arbitrary arrest; and out of the discussion which then arose, and the contests respecting the levying of ship-money, &c., came the distinct assertion, and ultimate establishment of the great principle of English liberty. The 13 Car. II. stat. 1, c. 4, provides for a voluntary present to his majesty, with a proviso, however, that no aids of that nature can be but by authority of parliament. The Bill of Rights, in 1688, repeats what Magna Charta declared in 1215, that levying of money for, or to the use of the crown, by pretence of prerogative, without grant of parliament, for longer time, or in any other manner than the same is or shall be granted, is illegal.

(Hallam's *Constitutional History of England*, and Knight's *Popular History of England*.)

BENGALI LANGUAGE. Among the numerous vernacular dialects now spoken in northern India, and apparently descended for the most part from the ancient classical language of the country, the Sanscrit, few possess stronger claims upon the attention of the linguist as well as the politician than the Bengâlî, the colloquial medium of a population of more than twenty millions, spread over a territory of about 100,000 square miles. The alphabet employed by the natives in writing, and adopted by Europeans in printing books in the Bengâlî language, is evidently borrowed from the Devanâgari, the character peculiarly appropriated to fix the Sanscrit language: both comprise sixteen vowels and diphthongs, and thirty-three consonants. The resemblance in form which the Bengâlî bears to the Devanâgari character is nearly the same as that of the current English handwriting to the form of letters employed in printing. The ground-work of the Bengâlî language is Sanscrit, with a small addition of words which cannot be traced to that source. But the refined system of grammatical inflexions, which constitute so prominent a characteristic of the Sanscrit language, has in Bengâlî entirely disappeared; and the want of terminations marking the cases and numbers of the noun, or the persons and tenses of the verb, is supplied by particles and other auxiliary words, often rather clumsily subjoined (hardly ever prefixed) to the mutilated stems of Sanscrit words, and these particles to some extent supply the place of articles; placed after a noun or adjective it is definite, before either it marks it as indefinite. The Bengâlî has, however, preserved to a very considerable extent the faculty, so conspicuous in Sanscrit, of forming compound words, and recent writers have largely availed themselves of this advantage, especially in treatises on Hindoo law and on philosophical subjects: we allude especially to the Bengâlî translation of the second book of the 'Mitâksharâ' (a Sanscrit law-book of high authority), published by Lakshmî Nârâyana Nyâyâlankâra (in 1824, 8vo.), and to that of the 'Nyâyadarsana,' by Kâsinâtha Tarkopanchânana.

It does not appear that the Bengâlî language was ever employed for literary purposes prior to the 16th century. The earliest Bengâlî work extant is the 'Chaitanya-Charitâmrita,' by Krishnadâsa, a disciple of the Vaishnava fanatic Chaitanya, the founder of a new mode of the worship of Krishna, who lived towards the close of the 15th century. This work, which is almost as much Sanscrit as Bengâlî, was till within very recent times followed by only a few compositions, the most important of which were the poetical versions, from Sanscrit into Bengâlî, of the 'Mahâbhârata,' by Kâsidâsa, and of the 'Râmâyana,' by Kritivâsa; these works are very popular in Bengal, and are frequently recited at the houses of Hindoos during several days, before assemblies of two or three hundred auditors. Khemananda is named as the author of a hymn called 'Manasâ-mangala,' which is still recited at the festivals in honour of the goddess Manasâ, in the western provinces of Bengal. A treatise on arithmetic, written in verse, is ascribed to Subhancara: this work, and a treatise called 'Gurudakshinâ,' appear to have been the only elementary books composed by natives of Bengal for the purposes of education. A new epoch in Bengâlî literature was begun with the foundation of the college of Fort William near Calcutta, and with the labours of Dr. Carey and his colleagues the Serampore missionaries, to whom, according to the expression of a native author, may be ascribed "the revival of the Bengâlî language, its improvement, and in fact its establishment as a language." The Bible and various works of modern literature were translated into Bengâlî, and printed: among others, 'Bunyan's Pilgrim's Progress,' by F. Carey (Serampore, 1821), 'Rasselas,' by Râjâ Krishnachandra Roy, and the 'Discourse on the Advantages of Knowledge,' published by the Society for the Diffusion of Useful Knowledge. At the same time various elementary works were printed, partly by the mission press at Serampore, and partly under the superintendence of the Calcutta School-Book Society. An impulse was thus given to the cultivation of the language among Europeans as well as among the natives, and the taste of the latter for reading is attested by the fact that several newspapers in the Bengâlî language are circulated in Calcutta and its vicinity; the extension of the means of education have been mentioned under BENGAL, in GEOG. DIV. A Dictionary in English and Bengâlî, translated from Todd's

edition of Johnson's English Dictionary, by Râm Comulsên (Serampore, 1834, 2 vols, 4to.), is a work which does high honour to the zeal and perseverance, and, as far as we may presume to give an opinion, to the talent and skill of the translator. We are indebted to the author's preface for the greater part of the preceding remarks concerning the literature of the Bengâlî language.

From the alterations which have been made in the selection of cadets for the East India Company's service, a knowledge of this language has become highly important. To those who wish to commence the study of the Bengâlî language, the following elementary works will be found useful: 'A Grammar of the Bengâlî Language,' by the Râjâ Rammohun Roy; and 'A Grammar of the Bengalee Language, adapted for Natives and Europeans,' by a Native, Calcutta, 1850; there are also the Dictionary above-mentioned, that of Dr. Carey, and others, including abridgements.

BENI is a form of the plural of the Arabic word *Ebn* or *Ibn*, "a son." It occurs in eastern geography as a component part of many names of families or tribes, as *Beni Temîm*, "the sons of Temîm," that is, the tribe of Temîm, or the Temîmides; *Beni Omayyah*, "the sons of Omayyah," that is, the family known in history under the current name of the Ommiades: *Tiah Beni Israel*, "the desert of the sons of Israel," the name of a dreary wilderness towards the north of Mount Sinai.

BENIC ACID ($C_{44}H_{43}O_3HO$). An acid obtained by the saponification of *oil of ben*. It fuses at 169°, and forms salts and an ether.

BENZAMIDE. [Benzoic Group; Amides.]

BENZIDAM. [Aniline.]

BENZIDINE. [Phenylic Group.]

BENZILE. [Benzoic Group.]

BENZILIC ACID. [Benzoic Group.]

BENZIMIDE, $C_{46}N_2H_{18}O_4$, *Hydride of Cyanbenzoyl*. This is one of the numerous compounds described by Laurent as the result of the study of hydride of benzoyl, the oil of bitter almonds. It is found in the oil in a crude state. It is crystallisable, and is decomposed by acids into benzoic acid, formic acid, and ammonia.

BENZINE. [Benzole]

BENZOATES. [Benzoic Acid.]

BENZOENE, a name synonymous with *Toluole*. [Toluole.]

BENZOGLYCOLLIC ACID, $C_{18}H_7O_7 + HO$. This acid is formed when hippuric acid is exposed to the action of hyponitrous acid. It is crystalline, soluble in alcohol and ether, less soluble in cold water. When heated with acids it is decomposed, yielding benzoic acid and glycollic acid.

BENZO'IC ACID ($C_{14}H_5O_3,HO$). This acid, as its name imports, is usually obtained from the resinous substance called gum benzoin or benjamin; it occurs also in some other vegetable bodies, as the balsam of Peru and of Tolu, storax, in the flowers of the *Trifolium melilotus officinalis*, and in the yellow Australian gum obtained from the *Xanthorrhœa hastilis*. It is found also in the urine of the cow, horse, and other herbivorous animals, and also in that of children.

It may be prepared from benzoin either by sublimation or by precipitation; the former method is employed in the London, and the latter in the Berlin Pharmacopœia. The process of sublimation is perfectly simple; the benzoin being subjected to a moderate heat in a proper vessel, the benzoic acid rises in vapour and is condensed in the upper and cool part of it. As thus obtained, it is mixed with a considerable quantity of empyreumatic oil, which gives it both colour and smell; the greater part of this oil is separated by absorption and pressure, and the acid being then resublimed, retains but little, and derives from it an agreeable odour; it is frequently called *flowers of benzoin* or of *benjamin*.

In the Berlin Pharmacopœia four parts of benzoin, reduced to powder, are first digested and then boiled in water, with nine parts of carbonate of soda; the solution of benzoate of soda thus formed is decomposed by sulphuric acid, which, combining with the soda, separates the benzoic acid, the greater part of which is precipitated, owing to its slight solubility.

Benzoic acid may also be obtained by boiling hippuric acid (obtained from cow's urine) with concentrated hydrochloric acid. [Hippuric Acid.]

Benzoic acid possesses the following properties: when pure it crystallises in colourless, pearly, elastic needles, which are perfectly inodorous; its taste is rather aromatic and penetrating, than sour; by exposure to the air it undergoes no change; it requires two hundred times its weight of cold, or twelve of boiling water for solution; on cooling, a crystallised mass is obtained, which resembles fat in appearance; alcohol takes it up readily and in large quantity; prismatic crystals are procured by the spontaneous evaporation of the spirit. The aqueous solution acts but feebly upon litmus paper; it combines readily with alkalis, earthy and metallic oxides, forming salts which are called *benzoates*.

Benzoic acid fuses at 248° Fahr., and sublimes at 293°. It boils at 462°. Suddenly heated in the open air it takes fire, and burns with a bright yellow flame. When its aqueous solution is boiled, much benzoic acid passes off with the aqueous vapour. Administered to animals it is transformed into hippuric acid, and is found as such in their urine.

Anhydrous benzoic acid $\left(\begin{matrix}C_{14}H_5O_2\\C_{14}H_5O_2\end{matrix}\right\} O^2\Big)$ is prepared by acting upon the benzoate of soda with pentachloride or oxychloride of phosphorus. It is formed also when benzoate of soda is heated to 266° Fahr. with chloride of benzoyl, or when chloride of benzoyl is heated over a lamp with neutral oxalate of potash. (Gerhardt, 'Chemie Organique,' vol. iii. p. 207). The most advantageous method for its preparation is with the oxychloride of phosphorus. Oxychloride of phosphorus being placed in a flask, a little more than five times its weight of finely powdered anhydrous benzoate of soda is added in small quantities at a time with repeated agitation. The flask is then heated to 316° Fahr. on a sand bath. The product is then washed with cold water containing a little carbonate of soda which removes the chloride of benzoyl which may have been formed in small quantities. The ultimate reaction is

$$\underbrace{6NaOC_{14}H_5O_3}_{\text{Benzoate of Soda.}} + \underbrace{PO_2Cl_3}_{\text{Oxychloride of Phosphorus.}} = \underbrace{3NaO,\,PO_5}_{\text{Phosphate of Soda.}} + 3NaCl + \underbrace{3\left.\begin{matrix}C_{14}H_5O_2\\C_{14}H_5O_2\end{matrix}\right\}O_2}_{\text{Anhydrous Benzoic acid.}}$$

The anhydrous benzoic acid may be purified by distillation, it melts at 108° Fahr., and boils at about 590°. It dissolves in alcohol and ether, separating from such solutions in oblique prisms. It is quite insoluble in cold water; on boiling with water, it becomes gradually hydrated, being converted into ordinary benzoic acid. It readily unites with the alkalis, on being boiled with their aqueous solutions, giving rise to the corresponding benzoates. With hot aqueous ammonia it forms benzamide [*Benzamide*] and benzoate of ammonia.

Compounds exist of anhydrous benzoic acid with other anhydrous acids. Such are anhydrous acetobenzoic and valerobenzoic acids. They are formed by the action of anhydrous benzoate of soda upon the chlorides of acetyl, valeryl, &c.

$$C_4H_3O_2Cl + NaOC_{14}H_5O_3 = NaCl + C_4H_3O_3C_{14}H_5O_3,$$
$$O_{10}H_9O_2Cl + NaOC_{14}H_5O_3 = NaCl + C_{10}H_9O_3C_{14}H_5O_3, \quad \&c.$$

These bodies are heavier than, insoluble in, but gradually decomposed by water, as also by distillation *per se* into the constituent anhydrous acids. In a similar manner are formed compounds of anhydrous benzoic acid, with anhydrous œnanthylic, pelargonic, salycilic, cumic, myristic, and cinnamic acids. [Anhydrides.]

Anhydrous nitrobenzoic acid $\left(\begin{matrix}C_{14}H_4(NO_4)O_2\\C_{14}H_4(NO_4)O_2\end{matrix}\right\} O_2\Big)$, which contains two molecules of NO_4 in place of two atoms of hydrogen, is obtained by acting upon 8 parts by weight of dry nitrobenzoate of soda with 1 part of oxychloride of phosphorus. The two are heated for some time in a flask at 300° Fahr., until the smell of chloride of nitrobenzoyl disappears. Anhydrous nitrobenzoic acid is thus obtained as a white mass which may be washed with cold water. Anhydrous nitrobenzoic acid is almost insoluble in boiling alchohol and ether; it is soon hydrated on contact with water, being converted into ordinary nitrobenzoic acid. (Gerhardt, 'Ann. de Chem. et de Phys.' xxxvii. 321.)

Benzoic acid combines readily with the alkalis directly, it also decomposes their carbonates, driving out their carbonic acid, and forming in both cases benzoates. From the benzoates of the alkalis the benzoates of the heavy metals may generally be prepared by double decomposition. The latter benzoates (those of the heavy metals), as well as the benzoates of the alkaline earths, may also be obtained by digesting benzoic acid with the corresponding oxides.

Benzoic acid forms two salts with potash. *Neutral benzoate of potash* ($KO\,C_{14}H_5O_3 + HO$) is best obtained by neutralising a boiling aqueous solution of benzoic acid with carbonate of potash, evaporating on a water bath, to dryness, boiling with alcohol, filtering, evaporating on a water bath, and allowing to stand: the neutral benzoate of potash separates out as the solution cools. The water is given off on exposure to the air. The acid salt of potash ($KOC_{14}H_5O_3 + HOC_{14}H_5O_3$) or *benzoate of potash and water* is often formed in the preparation of anhydrous acetic acid by the action of chloride of benzoyl upon acetate of potash, and remains in the residue from which the anhydrous acetic acid has been distilled. It is less soluble than the preceding neutral salt.

Benzoate of soda ($NaO\,C_{14}H_5O_3 + ?\,HO$) is obtained by neutralising benzoic acid with carbonate of soda. As the benzoate of soda is only slightly soluble in alcohol it cannot be purified as the corresponding potash salt. Benzoate of soda is efflorescent, which shows that it contains water of crytallisation.

Neutral benzoate of ammonia can only be prepared by neutralising aqueous solution of benzoic acid with ammonia, and adding ammonia frequently during the evaporation of the solution: in this manner a salt is obtained ($NH_4OC_{14}H_5O_3 + ?\,HO$) which crystallises in rhombic tables, and is easily soluble in water and alcohol. If no ammonia be added during the evaporation of the neutralised solution, or if such a solution containing the neutral salt be exposed to the air, ammonia is discharged and an acid salt crystallises out which is less soluble in alcohol and water than the neutral salt: its composition is $NH_4OC_{14}H_5O_3HOC_{14}H_5O_3 + ?\,HO$.

Dry benzoate of ammonia when heated gives off water (a little ammonia) and cyanide of phenyl,

$$\underbrace{NH_4OC_{14}H_5O_3}_{\text{Benzoate of Ammonia.}} = 4HO + \underbrace{C_{12}H_5,\,C_2N.}_{\text{Cyanide of Phenyl.}}$$

The latter body is also called *benzonitrile*.

Benzoate of lime ($CaO\ C_{14}H_5O_3 + 4HO$) is prepared by neutralising benzoic acid with milk of lime, precipitating the slight excess of lime with carbonic acid, warming, filtering, and evaporating. Benzoate of lime crystallises in needles or nuclei, which dissolve in from 20 to 30 parts of cold water. On heating benzoate of lime, a part of the carbon remains behind to form carbonate of lime, the rest is given off as benzole, napthaline, and other hydrocarbons.

Benzoate of baryta ($BaOC_{14}H_5O + 2HO$), and *Benzoate of strontia* ($SrOC_{14}H_5O + 2HO$) are very similar in their preparation and properties to the lime salt; they are, however, less soluble than the latter in cold water. They do not effloresce in the air.

Benzoate of magnesia ($MgOC_{14}H_5O_3 + ?HO$), prepared like the salts of the alkaline earths, is very soluble in water, and crystallises from its solutions in well-defined efflorescent crystals.

Benzoate of alumina is crystalline and soluble in water, but its exact composition is not known.

The *benzoates of zinc, nickel, cobalt*, and *protoxide of iron* are soluble and crystallisable. The zinc salt is colourless, that of nickel green, that of cobalt red, and that of protoxide of iron is nearly colourless, but becomes green on exposure to the air. The peroxide of iron forms several compounds with benzoic acid. The *neutral benzoate of iron* dissolves partly in water, leaving a residue of a subsalt. An insoluble *benzoate of peroxide of iron* is also formed by adding benzoate of ammonia to a solution of chloride of iron nearly neutralised by ammonia: the benzoate of iron so formed is said to have the composition, $2Fe_2O_3, 3C_{14}H_5O_3 + 15HO$.

Benzoate of manganese ($MnOC_{14}H_5O_3$) dissolves in 20 parts of cold, and less of hot water; it crystallises from its solutions in transparent needles.

Benzoate of cadmium ($CdO\ C_{14}H_5O_3 + 2HO$), prepared by saturating hot aqueous solution of benzoic acid with carbonate of cadmium, filtering and evaporating; crystallises in a mass of brilliant acicular crystals.

Benzoate of copper ($CuOC_{14}H_5O_3$). When sulphate of copper is treated with a hot solution of benzoate of potash, a number of small light bluish-gray needles of the benzoate of copper are precipitated, which, on recrystallising from warm dilute acetic acid, are obtained as green anhydrous crystals insoluble in alcohol. The products of the destructive distillation of benzoate of copper, are principally benzoic acid, benzole, and benzoate of phenyl.

Mercury forms with benzoic acid two salts, corresponding to the stages of oxidation of the mercury. *Mercuric benzoate* ($HgOC_{14}H_5O_3 + HO$) is precipitated as a white crystalline substance on adding benzoate of potash to perchloride of mercury. It is very soluble in hot, but insoluble in cold water. *Mercurous benzoate* ($Hg_2OC_{12}H_5O_2$), prepared similarly to the mercuric salt, resembles it in its appearance and solubility in water. It is however turned yellow on exposure to the light; and on boiling, it is decomposed, metallic mercury being precipitated.

Benzoate of silver ($AgOC_{14}H_5O_3$) is precipitated as a thick white mass by bringing together soluble silver and benzoic salts. It is almost insoluble in cold, but partially soluble in hot water, from which solution it separates on cooling in the form of long crystalline scales.

Benzoate of lead ($PbOC_{14}H_5O_3 + HO$) is precipitated as a voluminous crystalline powder, on mixing acetate of lead with benzoate of potash. The water is driven off at about 212° Fahr., at which temperature the salt melts. Benzoic acid also forms with lead other more basic compounds, the constitution of which is little known.

Benzoic acid combines also with the oxides of the organic radicals, forming with them the corresponding benzoic ethers. The above-described double anhydrous acids, namely, acetobenzoic and valerobenzoic acid ($C_4H_3O_3C_{14}H_5O_3$ and $C_{10}H_9O_3O_{14}H_5O_3$), may be viewed as benzoates of the oxides of the oxy-radicals, acetyl or othyl ($C_4H_3O_2$), and valeryl ($C_{10}H_9O_2$).

Benzoate of methyl ($C_2H_3O\ C_{14}H_5O_3$). To prepare this substance, two parts by weight of benzoic acid are placed in a retort, and a mixture of two parts of monohydrated sulphuric acid with one part of methylic alcohol is added, and the whole distilled until no more benzoate of methyl appears in the distillate. Water is then added to the residue in the retort, and the distillation repeated. It is advantageous that the sulphuric acid and methylic alcohol should be mixed a day or two beforehand, in order that methylosulphuric acid may have been fully formed. The distillate is heated in a water bath, to expel the uncombined methylic alcohol, dried with chloride of calcium, and rectified from oxide of lead, which retains any benzoic and sulphuric acids which have been carried over mechanically, and sulphurous acid which has been formed. Benzoate of methyl is a transparent colourless liquid, of pleasant odour, miscible with ether and alcohol, insoluble in water. Boiling-point 388° Fahr.; specific gravity, 1·087 at 60°. Vapour density, 4·717.

Benzoate of ethyl—Benzoic ether ($C_4H_5O, C_{14}H_5O_3$) is formed by digesting for several hours, in a retort connected with an inverted and well-cooled condenser, four parts by weight of ethylic alcohol (89°-90° *per cent*), two parts of benzoic acid, and one part of fuming hydrochloric acid. After the contents of the retort have stood a day, the alcohol is distilled off from a water bath, and the benzoate of ethyl precipitated by the addition of water to the residue in the retort.

Another method is, to dissolve three parts of benzoic acid in two parts of boiling alcohol, in a retort arranged as before, and to saturate the mixture with gaseous hydrochloric acid, and proceed as before. The product from either mode of preparation is agitated with aqueous carbonate of soda, washed with water, dried with chloride of calcium, and rectified from oxide of lead. Benzoate of ethyl is transparent, colourless, and of agreeable odour. Boiling-point, 415° Fahr.; specific gravity, 1·055 at 50°; vapour density, 5·406. Benzoate of ethyl, when taken internally, has an intoxicating action, and is converted in the system into hippuric acid, which appears in the urine.

Benzoate of amyl ($C_{10}H_{11}O, C_{14}H_5O_3$) is prepared in the same manner as the benzoate of ethyl, amylic alcohol being substituted for the ethylic. It is a yellowish liquid, insoluble in water, but soluble in ether and alcohol. Boiling-point, 502°; specific gravity, 0·992 at 57°.

Benzoate of phenyl—Benzophenide ($C_{12}H_5O, C_{14}H_5O_3$). When carbolic acid is gently heated with chloride of benzoyl until hydrochloric acid ceases to be evolved, the product on cooling solidifies to a crystalline mass containing the benzoate of phenyl.

$$\underbrace{C_{12}H_6O_2}_{\text{Carbolic acid.}} + \underbrace{C_{14}H_5O_2Cl}_{\text{Chloride of Benzoyl.}} = \underbrace{C_{12}H_5OC_{14}H_5O_3}_{\text{Benzoate of Phenyl.}} + HCl.$$

The compound is obtained pure by solution in a mixture of alcohol and ether, and evaporation; an insoluble oily body which is generally formed, and which is probably a mixture of the benzoate of phenyl with some benzoate of ethyl, being mechanically separated. Benzoate of phenyl possesses the odour of geraniums; it crystallises in rhombs, which melt at 158° Fahr.

All these three organic benzoates are slowly converted by hydrate of potash into benzoate of potash and the corresponding alcohols; and this decomposition is effected more rapidly if alcoholic caustic potash be employed. Anhydrous benzoic acid may also be made to combine directly with the aldehydes, ethylic aldehyde and valeral, by sealing the two together in glass tubes, and heating to 63°. The compounds formed have the composition $C_4H_4O_2, 2C_{14}H_5O_3$ and $C_{10}H_{10}O_2, 2C_{14}H_5O_3$.

Benzoic acid unites directly with anhydrous sulphuric acid, forming therewith a copulated acid, *sulphobenzoic acid* ($C_{14}H_6O_4\ 2SO_3$) As this acid, however, combines with two atoms of base to form neutral salts, its formula is probably $2HO, C_{14}H_4O_2 2SO_3$. The acid is prepared by leading the vapour of anhydrous sulphuric acid into benzoic acid as long as heat is evolved. On treating the transparent mass so obtained with water, and filtering, the free benzoic acid, being insoluble, is separated. The filtrate is then saturated with carbonate of baryta and filtered, whereby the free sulphuric acid remains behind as insoluble sulphate. Enough hydrochloric acid is then added to the warm filtrate to combine with half the barium present; this converts the soluble neutral sulphobenzoate into an insoluble acid, sulphobenzoate of baryta, which separates out on cooling, and may be purified by recrystallisation. The free acid is obtained from the acid baryta salt by precipitating the baryta exactly with sulphuric acid, filtering and evaporating, until a temperature of 300° Fahr. is reached. On cooling, the sulphobenzoic acid separates out in the crystalline form.

Of the *sulphobenzoates*, the *baryta salts* may be got by evaporating the two solutions described in the above preparation of the free acid, before and after the addition of the hydrochloric acid. The neutral salt is anhydrous ($2BaOC_{14}H_4O_2 2SO_3$), and exceedingly stable. The acid salt contains three atoms of water of crystallisation. The *acid* and *neutral potash salts* are got from the corresponding baryta compounds, by exact precipitation with sulphate of potash, and filtration. The first is efflorescent, the second deliquescent, in the air. *Neutral sulphobenzoates* of *lead* and *silver* are formed by digesting the free acid with the corresponding metallic carbonates. The lead salt contains four, the silver two, atoms of water.

A *sulphobenzoate of ethyl* has been also formed by the action of the chloride of sulphobenzoyl upon alcohol. Its properties have not been much studied.

By acting upon sulphobenzoic acid with pentachloride of phosphorus, a peculiar acid is obtained, which contains an atom of chlorine in place of one of hydrogen; this is *chlorobenzoic acid*, $\left(HO, C_{14}\overset{H_4}{Cl}O_3\right)$. Its formation is preceded by that of the chloride of chlorbenzoyl $\left(C_{14}\overset{H_4}{Cl}O_2Cl\right)$, and it is prepared as follows:—One part of sulphobenzoic acid is gently heated in a retort with two parts of pentachloride of phosphorus. The heat is then carried to 338° Fahr., at which temperature the oxychloride of phosphorus which has been formed passes over. On changing the receiver, and applying a stronger heat, sulphurous acid is disengaged, and the chloride of chlorbenzoyl distils. On agitating this product with water, it is decomposed into hydrochloric acid and chlorobenzoic acid. The latter may be purified by combining it with potash, then boiling with caustic potash, and precipitating by the addition of hydrochloric acid. Chlorobenzoic acid is a colourless solid, which melts at 284° Fahr and readily sublimes; it is soluble in ether, alcohol, and hot water, but insoluble in cold water. Chlorobenzoic acid may also be formed by boiling benzoic acid with chlorate of potash and hydrochloric acid. Fuming

nitric acid converts chlorobenzoic acid into *nitrochlorobenzoic acid* $\left(HOC_{14}\begin{matrix}H_3\\NO_4\\Cl\end{matrix}\right\}O_3\right)$. Chlorobenzoic acid combines directly with single atoms of the metallic oxides, forming therewith salts of which the potash and soda salts are uncrystallisable; the ammonia salt is decomposed on evaporation. The baryta and lime salts are crystallisable, and both contain three atoms of water. The silver, lead, and copper salts are insoluble, and should therefore be prepared by double decomposition: the first is crystalline, the two others amorphous. Chlorobenzoate of ethyl $\left(\begin{matrix}C_4H_5O,\\C_{14}H_4\\Cl\end{matrix}\right\}O_3\right)$ is a liquid which boils at 473° Fahr.; it is prepared by heating the free acid with alcohol and sulphuric acid, and precipitation with water.

An acid identical in composition with chlorobenzoic acid, when both are in the free state, is prepared by distilling together salicylic acid with pentachloride of phosphorus, and boiling the oily distillate (rectified at 392°-480° Fahr.) with water. Hydrochloric acid is thereby formed, and a crystalline substance separates out on cooling. This is the new acid. It is purified in the same manner as described for chlorobenzoic acid. The only observable difference between this body and chlorobenzoic acid is in the melting point of the former, 266°, and in the amount of water contained in its salts; the baryta salt being anhydrous, and the lime salt containing only two atoms of water. This acid has consequently been called *parachlorobenzoic acid*. The bromine acid corresponding to chlorobenzoic acid, namely, *bromobenzoic acid* $\left(HOC_{14}\begin{matrix}H_4\\Br\end{matrix}O_3\right)$, has been prepared by the action of bromine upon benzoic acid in the sunlight, and by the gradual action of bromine vapour upon benzoate of silver. Neither the free acid nor its salts have been much examined. The free acid melts at 212° Fahr., and sublimes (but not without decomposition). It is difficultly soluble in water, easily so in alcohol and ether.

Another substitution product of benzoic acid is the *nitrobenzoic acid* $\left(HOC_{14}\begin{pmatrix}H_4\\NO_4\end{pmatrix}O_3\right)$. This acid, which contains an atom of peroxide of nitrogen, NO_4, in place of one of hydrogen, is a product of the action of nitric acid upon benzoic acid. It is best prepared by mixing two parts of nitrate of potash with one part of benzoic acid, and adding enough strong sulphuric acid to form bisulphate of potash; the mass being constantly stirred during the addition of the sulphuric acid. The mass so obtained is heated until the nitrobenzoic acid melts; it is then poured off from the bisulphate of potash which has been formed, and purified by recrystallisation from boiling water. Nitrobenzoic acid consists of colourless crystals, which sublime with partial decomposition below their melting point, 338° Fahr., giving off suffocating fumes. It is readily soluble in boiling water, difficultly so in cold water. Nitrobenzoic acid decomposes the carbonates of the alkalies and alkaline earths, forming monobasic salts of the general formula $MO, C_{14}\begin{matrix}H_4\\NO_4\end{matrix}\Big\}O_3$. The *potash* and *soda salts* are difficultly crystallisable; the *ammonia salt*, as it exists in cold solutions, is decomposed by evaporation, an acid salt being formed. It is also gradually converted, on digestion, into nitrobenzamide. The *lime*, *strontia*, and *baryta salts* are soluble and crystalline, and contain 2, 2½, and 4 atoms of water respectively. The *manganese salt* is also soluble and crystalline, and contains four atoms of water, as also does the cadmium salt, which is soluble but not crystalline. The *sesqui-salt of iron* $\left(Fe_2O_3 3C_{14}\begin{pmatrix}H_4\\NO_4\end{pmatrix}O_3\right)$, and the *zinc*, *silver*, *lead*, and *copper salts*, are insoluble, and are formed by appropriate double decomposition from the ammonia salt. They are all anhydrous excepting the nitrobenzoate of zinc, which contains five atoms of water.

The *nitrobenzoates of methyl* and *ethyl* are prepared by dissolving nitrobenzoic acid in the respective boiling alcohols, and saturation with gaseous hydrochloric acid. The hydrochloric acid should be passed through for a long time, and the product allowed to stand for a day. On adding water, the corresponding nitrobenzoate is precipitated. The nitrobenzoate of ethyl $\left(C_4H_5OC_{14}\begin{pmatrix}H_4\\NO_4\end{pmatrix}O_3\right)$ so obtained is agitated with a warm solution of carbonate of soda, and then washed with cold water. The solid compound is then pressed between blotting-paper, and recrystallised from a mixture of alcohol and ether. The nitrobenzoate of methyl $\left(C_2O_3C_{14}\begin{matrix}H_4\\NO_4\end{matrix}\Big\}O_3\right)$ is obtained from its alcoholic solution (and the same method may also be employed with the ethyl compound) by evaporation. It separates out as fine needle-shaped crystals. The nitrobenzoate of ethyl melts at 108° Fahr., and boils at 568°. The methyl compound melts at 158°, and boils at 534°. Both nitrobenzoates are readily soluble in ether and alcohol, but insoluble in water. On boiling with hydrated potash, the alcohols are regenerated, and benzoate of potash formed.

By the continued action of nitric acid, assisted by the presence of sulphuric acid, upon benzoic acid, a second atom of hydrogen undergoes replacement by another atom of peroxide of nitrogen, and an acid is formed having the composition $HOC_{14}\begin{matrix}H_3\\(NO_4)_2\end{matrix}O_3$: this is *binitro-benzoic acid*. To prepare it, small quantities of benzoic acid are successively added to a mixture of fuming nitric and monohydrated sulphuric acids. When complete solution has been effected, the product is heated for several hours until it begins to become turbid. It is then allowed to cool, and is mixed with water. The insoluble flocculent portion is washed with water, pressed between blotting-paper, and recrystallised from boiling alcohol, from which it crystallises in bright colourless scales. Binitrobenzoic acid is also soluble in ether, almost insoluble in cold, but slightly soluble in boiling water. Strong nitric and sulphuric acids dissolve binitrobenzoic acid in considerable quantity without decomposition. It is readily fusible, and may be sublimed with care without decomposition. The salts of the alkalies with this acid, being soluble, are prepared by direct neutralisation. The lead and silver compounds are insoluble, and must therefore be formed by double decomposition.

Binitrobenzoate of ethyl $\left(C_4H_5O, C_{14}\begin{matrix}H_3\\(NO_4)_2\end{matrix}O_3\right)$ is slowly formed upon boiling binitrobenzoic acid with alcohol. A portion of the binitrobenzoate of ethyl separates from the alcoholic solution in oily drops; the remainder, which is dissolved in the alcohol, is precipitated therefrom, along with uncombined binitrobenzoic acid, on the addition of water. The latter is removed by digestion with ammonia; the product thus purified is then washed with water and dissolved in boiling alcohol. The pure ether separates from the alcoholic solution, on cooling, in the form of long silky needles of a faint yellow colour.

Alcoholic ammonia converts binitrobenzoic acid into *binitrobenzamide* $\left(N\begin{matrix}H_2\\C_{14}H_3(NO_4)_2O_2\end{matrix}\right)$. Caustic potash, when boiled with binitrobenzoate of ethyl, determines the formation of dinitrobenzoate of potash and the separation of alcohol.

A part of the hydrogen of benzoic acid may undergo replacement by chlorine, and another part by NO_4, and the product still maintain its acid character. Such is the *nitrochlorobenzoic acid* $\left(HOC_{14}\begin{matrix}H_3\\Cl\\NO_4\end{matrix}O_3\right)$. To prepare this acid, chlorobenzoic acid is treated with fuming nitrid acid. The product, after standing some hours, is mixed with water, which after some days determines the separation of the new acid, in the form of transparent tabular crystals, which melt at 244°, and may be recrystallised from ether or alcohol, but not from water. The *nitrochlorobenzoates of baryta* and *silver* are both monobasic, and contain two equivalents of water. The *silver salt* is crystalline, and tolerably soluble in water; the *baryta* one is amorphous, and more readily soluble.

It is clear that anhydrous benzoic acid, $\begin{matrix}C_{14}H_5O_2\\C_{14}H_5O_2\end{matrix}\Big\}O_2$, may be viewed as the oxide of an oxygen radical ($C_{14}H_5O_2$). This radical, which is called *benzoyl*, may, like acetyl and the hydrocarbon radicals, play the part of an atom of hydrogen. By the replacement of a portion of the hydrogen of ammonia by benzoyl, a substance, *benzamide*, $N\begin{matrix}C_{14}H_5O_2,\\H_2\end{matrix}\Big\}$ is obtained. [AMIDES.]

BENZOIC ACID, *Medical uses of*. There is some difference in the qualities of the acid, according to the source whence it is obtained: for medical purposes the acid procured from benzoin by sublimation, and termed "flowers of benzoin," should alone be used.

Sublimed benzoic acid occurs in white, needle-like prisms, which, when in mass, have a flocculent appearance, with a soft, silky lustre. The odour is said to be owing to a little empyreumatic oil; the taste is at first sweetish, but afterwards very pungent; the specific gravity is 0·657. Its acid quality is manifested by reddening turmeric paper; it is scarcely soluble in water, whether warm or cold; it is completely soluble in alcohol: it therefore enters into the composition of the *Tinctura camphoræ composita* of the 'London Pharmacopœia,' and the *Tinctura opii ammoniata* of the 'Edinburgh Pharmacopœia,' two preparations long known under the name of paregoric elixir. The use of these requires care and judgment. [BALSAMS.]

Benzoic acid has been recommended to be inhaled with the vapour of water in consumption and spasmodic asthma. In the former of these diseases it is of no efficacy, and in the latter of very little. Benzoic acid, combined with extract of conicum, forms a useful expectorant in the humid asthma of old or feeble persons.

Benzoic acid alone, or in combination with ammonia, is of undoubted value in the treatment of atonic gout. (See Ure in 'Medico-Chirurg. Trans.' vol. xxiv. p. 30; and 'Pharmaceut. Trans.' vol. i. p. 24.)

BENZOIC ALCOHOL. *Hydrate of Toluyl* $\left(C_{14}\begin{matrix}H_7\\H\end{matrix}\Big\}O_2\right)$. This body, which stands to benzoic acid in the same relation as vinic alcohol to acetic acid, is produced by the action of an alcoholic solution of potash upon hydride of benzoyl:—

$$\underbrace{2(C_{14}H_6O_2}_{\text{Hydride of benzoyl.}} + KO, HO = \underbrace{C_{14}H_8O_2}_{\text{Benzoic alcohol.}} + \underbrace{C_{14}H_5O_3, KO.}_{\text{Benzoate of Potash.}}$$

It is highly probable that the *Taurylic Acid* found by Staedeler in the urine of the horse and cow, and in human urine, is identical with benzoic alcohol. Benzoic alcohol is a colourless oil, heavier than water. It boils at 400° Fahr. Oxidising agents convert it into benzoic acid, just as they convert vinic alcohol into acetic acid.

BENZOIC ETHER. [BENZOIC ACID.]

BENZOIC GROUP. A very numerous family of organic compounds, constituting one of the groups of the benzoic series [BENZOIC SERIES], and containing the radical benzoyl, or its derivatives. In addition to a number of substances, which will be found in their alphabetical position, this group contains the following compounds :—

Benzoine? ($C_{14}H_6O_2$). The name benzoine is given to the solid substance obtained by the action of alcoholic caustic potash upon hydride of benzoyl, or oil of bitter almonds ($C_{14}H_5O_2H$), which contains hydrocyanic acid, or by the action of cyanide of potassium upon the pure hydride of benzoyl. As hydride of benzoyl is most consistently to be viewed as an aldehyde, so benzoine stands probably in the same relation to hydride of benzoyl that metaldehyd does to vinic aldehyd.

$C_{14}H_5O_2H$, hydride of benzoyl; $C_4H_3O_2H$, hydride of ethyl, or aldehyd.
$2(C_{14}H_5O_2H)$ benzoine; $2(C_4H_3O_2H)$ metaldehyd.

If the crude oil of bitter almonds contains a sufficient quantity of hydrocyanic acid, it is quickly converted into a mass of crystalline benzoine on being mixed with a solution of caustic potash in alcohol; and from this mass the pure benzoine is obtained by repeated crystallisation from alcohol. If the oil of bitter almonds is too pure for this, instead of caustic potash an alcoholic solution of cyanide of potassium is employed, and the same process of purification adopted. The nature of the action of the cyanogen in polimerising the hydride of benzoyl is not understood. Benzoine melts at 248° Fahr., and distils at a higher temperature without decomposition. It is insoluble in cold, slightly soluble in hot water,—difficultly soluble in cold, readily soluble in boiling alcohol. Benzoine is re-converted into hydride of benzoyl on being passed through a red-hot tube. On heating benzoine in dry chlorine two atoms of hydrogen are removed in combination with chlorine, and *benzile* is formed.

$$2(C_{14}H_6O_2) + 2Cl = \underbrace{2(C_{14}H_5O_2)}_{\text{Benzile.}} + 2HCl.$$

The same elimination of hydrogen and formation of benzile is effected by gently heating the benzoine with fuming nitric acid: Fused hydrate of potash determines the formation of benzoate of potash; hydrogen being liberated—

$$2(C_{14}H_6O_2) + 2KO\,HO = 2(KOC_{14}H_5O_3) + 4H,$$

while alcoholic caustic potash on boiling, converts benzoine into *benzilic acid*, which unites with the potash, hydrogen, as before, being set at liberty—

$$2(C_{14}H_6O_2) + KO\,HO = KOC_{28}H_{11}O_5 + 2H.$$

On bringing benzoine in contact with the chlorides of the oxygen radicals benzoyl or othyl, hydrochloric acid is evolved, and the place of the hydrogen, which is derived from the benzoine, is occupied by the oxygen radical employed. These products which are solid crystalline bodies, are freed from hydrochloric acid by being heated on a water-bath and recrystallised from alcohol.

$C_{28}{}^{H_{11}}_{C_4H_3O_2}\Big\}O_4$; *Acetyl benzoine.*

$C_{28}{}^{H_{11}}_{C_{14}H_5O_2}\Big\}O_4$; *Benzoyl benzoine.*

Benzoyl ($C_{14}H_5O_2$). This oxygenous radical of the benzoyl series, which stands in the same relation to benzoic acid that othyl ($C_4H_3O_2$) does to acetic acid, has never yet been obtained in the free state. For benzile [BENZOINE], although having the same composition as benzoyl, and like all hitherto isolated organic radicals having the double atomic weight of the same radical when in combination, yet has properties so different from those which we should expect from the free radical, that it must be viewed as a body merely isomeric with benzoyl. The compounds of benzoyl are of great historical interest, inasmuch as their study first established the possibility of a group of elements containing oxygen, playing the part of a compound radical, that is, of an element.

The *oxide of benzoyl* ($C_{14}H_5O_2, O)_2$, or anhydrous benzoic acid. [BENZOIC ACID; ANHYDRIDES.]

Chloride of Benzoyl ($C_{14}H_5O_2\,Cl$), is formed directly from the hydride by passing dry chlorine into the latter, and warming as long as hydrochloric acid is evolved, $C_{14}H_5O_2\,H + 2Cl = C_{14}H_5O_2\,Cl + HCl$. A better way consists in gently heating in a retort 3 parts by weight of previously fused and coarsely pounded benzoate of soda with 1 part of oxychloride of phosphorus, $3(NaO\,C_{14}H_5O_3) + PO_2Cl_3 = 3(C_{14}H_5O_2\,Cl) + 3NaO\,PO_5$, and rectifying the distillate at 385°. Chloride of benzoyl is a colourless liquid of most penetrating odour and burning taste. Specific gravity, 1·196; boiling point, 385°; vapour density, 4·987. It is converted gradually by cold, and quickly by boiling water into benzoic acid (benzoate of water), and hydrochloric acid. With alcohol the action is similar but more energetic, benzoate of ethyl being formed.

The chloride of bichlorobenzoyl, a body which stands in the same relation to benzoyl as chloroform (C_2HCl_3) does to formyl (C_2HO_2), and which may be called *chlorobenz* ($C_{14}H_5Cl_2\,Cl$) is formed by heating equivalent quantities of chloride of benzoyl and pentachloride of phosphorus at 392° Fahr. in a sealed glass tube for several days. The tube is then opened and the volatile portions expelled by a temperature of 230° Fahr. The residue, after agitation with caustic potash, washing with water, solution in alcohol and precipitation by water, constitutes the pure chlorobenz, which is a yellowish transparent liquid, soluble in ether and alcohol, but insoluble in water. It is not volatile without decomposition. The body just described is the chloride of benzoyl, in which the oxygen is replaced by chlorine. A body has been formed also by a replacement of a part of the *hydrogen* of the radical in chloride of benzoyl by chlorine. This substance results from the action of pentachloride of phosphorus upon chlorobenzoic acid [BENZOIC ACID]. On distilling the two together, and rectifying the distillate at 437°, a colourless transparent liquid is obtained, boiling at the above temperature, and soluble in alcohol and ether. Its composition is $C_{14}{}^{H_4}_{Cl}O_2Cl$, being the *chloride of chlorobenzoyl*. This substance dissolves in aqueous ammonia, the solution depositing yellow needles of *chlorobenzamine* $C_{14}{}^{H_4}_{Cl}O_2H_2N$.

A body ideotypic with the chloride of chlorobenzoyl is the *chloride of nitrobenzoyl* $\left(C_{14}{}^{H_4}_{NO_4}O_2Cl\right)$ prepared by the action of pentachloride of phosphorus upon nitrobenzoic acid [BENZOIC ACID]. The distillate produced by heating together nitrobenzoic acid and pentachloride of phosphorus is rectified, the latter portion being free from the oxychloride of phosphorus which is a by-product of the reaction, consists of the chloride of nitrobenzoyl, which is washed with water, dried over chloride of calcium and distilled. It boils at 509°. Chloride of nitrobenzoyl gives a series of compounds precisely analogous to those derived from chloride of benzoyl.

Bromide of benzoyl ($C_{14}H_5O_2Br$). If hydride of benzoyl be mixed with an excess of bromine, heat is evolved, hydrobromic acid liberated, and bromide of benzoyl formed. On heating the product, the hydrobromic acid is expelled along with the excess of bromine, and a half crystalline mass is obtained of pure bromide of benzoyl: a body of an odour similar to, but feebler than, that of the chloride. It is insoluble in, but slightly decomposed by, water; and soluble without decomposition in ether and alcohol.

Iodide of benzoyl ($C_{14}H_5O_2I$) is formed by warming iodide of potassium with chloride of benzoyl. When pure, iodide of benzoyl is colourless; it readily decomposes on heating, iodine being liberated. Its behaviour to water and solvents is the same as that of the bromide.

Cyanide of benzoyl ($C_{14}H_5O_2\,Cy$). Is obtained as a colourless liquid on rectifying the product produced by the distillation of equal equivalents of chloride of benzoyl and cyanide of mercury. On standing, the liquid solidifies; it may then be washed with water to remove the chloride of mercury, and pressed between bibulous paper. Cyanide of benzoyl melts at 88° Fahr., and boils at 405° Fahr. It is slowly decomposed by water, readily by the alkalies; in the latter case, benzoates and cyanides are found. Nascent hydrogen converts it into hydride of benzoyl and benzoine.

Sulphide of benzoyl ($C_{14}H_5O_2\,S$). Is a soft crystalline yellowish white body, obtained by distilling chloride of benzoyl with sulphide of lead. It is stable in its nature, and its properties have been little studied.

Cyanide of sulphobenzoyl, improperly called sulphocyanide of benzoyl, a body having the composition $C_{14}H_5S_2\,Cy$, is obtained by mixing ammonia, bisulphide of carbon, and hydride of benzoyl, and pressing out the crystals which form in the lower of the two layers of the mixture. On washing the crystals with ether, pure cyanide of sulphobenzoyl is obtained. The reaction is as follows: $C_{14}H_5O_2H + 3NH_3 + 2(CS_2) = C_{14}H_5S_2\,Cy + 2NH_4S + 2HO$. The cyanide of sulphobenzoyl is insoluble in water, but somewhat soluble in alcohol and ether. The products of decomposition are little understood.

Although benzoyl has not been obtained in combination with the metals directly, yet a compound of it with an organic radical, namely, phenyl, is known. This body, *Benzoyl-phenyl*, also called *Benzone* or *Benzophenone*, $C_{14}H_5O_2C_{12}H_5$ is the acetone of benzoic acid. It is prepared by the destructive distillation of benzoate of lime in presence of about $\frac{1}{10}$th of its weight of quicklime. The process is best conducted in an iron mercury bottle. Besides benzone the distillate contains, benzole, hydride of benzoyl, and other products; that portion of the distillate is collected which on rectification passes over between 599 and 617°. This portion solidifies on cooling, and is purified by repeated crystallisation from a mixture of alcohol and ether. Benzone melts at 115° Fahr., and boils at 599° Fahr. It is insoluble in water, soluble in strong sulphuric and nitric acids without change. If, however, fuming nitric acid be employed, the nitric acid eliminates two atoms of hydrogen and *binitro-benzone* results. It is most probable that of the two atoms of hydrogen removed, the one belonged to the phenyl, the other to the benzoyl, and that the rational formula of binitro-benzone is

$$C_{14}{}^{H_4}_{NO_4}O_2, C_{12}{}^{H_4}_{NO_4}.$$

It is prepared by warming benzone with fuming nitric acid, and dissolving the semi-solid product (after washing) in ether. The binitro-benzone crystallises from the ethereal solution as a yellowish white crystalline powder.

Benzonitril. [PHENYL, CYANIDE OF.]

The compounds of benzoyl formed upon the ammonia type are very numerous. Those compound ammonias which contain benzoyl in place of hydrogen, do not combine so readily with the hydracids to form

corresponding salts of the compound ammoniums, as is the case when the replacing organic radical contains no oxygen.

Benzamide or *benzamine* $\left(N\begin{matrix}C_{14}H_5O_2\\H_2\end{matrix}\right)$, is best prepared by pounding carbonate of ammonia of commerce in a mortar, and mixing it with chloride of benzoyl. If the carbonate be employed in excess, the product gently warmed to complete the reaction, and the chloride of ammonium extracted by water, benzamine is obtained, which may be further purified by solution in boiling water or alcohol. Benzamine is a colourless solid crystalline body, which melts at 239°, and distils at a higher temperature without alteration.

The *hydrochlorate of benzamine*, or *chloride of benzammonium* $\left(N\begin{matrix}C_{14}H_5O_2Cl\\H_3\end{matrix}\right)$, is formed on dissolving, by the aid of heat, benzamine in strong hydrochloric acid. On allowing the solution to cool, the chloride of benzammonium crystallises out in long prisms. This compound gives up its hydrochloric acid even on exposure to the air.

On mixing bromine with benzamine and allowing the mixture to stand for some days in a cool place, crystals are formed of a compound resulting from the union of bromo-benzamine with hydrobromic acid $\left(N\begin{matrix}C_{14}H_4O_2\\Br\\H_3\end{matrix}Br\right)$. This substance is the *bromide of bromobenzammonium*. Both ammonia and water decompose this substance, and give rise to benzamine.

Mercury benzamine.—Aqueous solution of benzamine dissolves oxide of mercury (HgO): the oxygen of which unites with and removes one of the equivalents of hydrogen in the benzamine, while the mercury takes the place of the hydrogen so extracted, forming *mercury benzamine* $\left(N\begin{matrix}C_{14}H_5O_2\\Hg\\H\end{matrix}\right)$, which crystallises out of a not too dilute solution. The mercury benzamine on being dissolved in hot alcohol, filtered, and allowed to cool, forms brilliant white scales.

Phenyl benzamine (*benzaniline*) $\left(N\begin{matrix}C_{14}H_5O_2\\C_{12}H_5\\H\end{matrix}\right)$, is formed on mixing chloride of benzoyl with phenylamine (aniline). The hydrochloric acid which is formed does not unite with the compound ammonia, but with the excess of phenylamine. The chloride of phenylammonium so formed is removed by boiling the product of the reaction with water, and the phenylbenzamine is recrystallised from boiling alcohol, from which it separates in brilliant scales.

By warming phenylbenzamine with chloride of benzoyl, the remaining equivalent of hydrogen in the phenylbenzamine is removed as hydrochloric acid, by the chlorine of the chloride of benzoyl, and its place is taken by the benzoyl of the latter body. A compound ammonia is thus formed, containing two equivalents of benzoyl and one of phenyl, and being therefore *Phenylbibenzamine* $\left(N\begin{matrix}(C_{14}H_5O_2)_2\\C_{12}H_5\end{matrix}\right)$. The product obtained by this reaction, which becomes solid on cooling, is digested with a solution of carbonate of soda, to remove the excess of chloride of benzoyl and free hydrochloric acid, and then recrystallised from boiling strong alcohol. So prepared it forms bright acicular prisms.

The preparation and properties of the following compound ammonias are so similar to those of the above bodies as to require no special description.

Nitrocumylbenzamine $\left(N\begin{matrix}C_{14}H_5O_2\\C_{18}H_{10}NO_4\\H\end{matrix}\right)$, by the action of chloride of benzoyl ($C_{14}H_5O_2Cl$) upon nitrocumylamine $\left(N\begin{matrix}C_{18}H_{10}NO_4\\H_2\end{matrix}\right)$. [CUMYL.]

Methylnitrophenylbenzamine $\left(N\begin{matrix}C_{14}H_5O_2\\C_{14}H_6NO_4\\H\end{matrix}\right)$, by the action of chloride of benzoyl ($C_{14}H_5O_2Cl$) upon $N\left\{\begin{matrix}C_{14}H_6NO_4\\H_2\end{matrix}\right.$ (methylnitrophenydine). [PHENYL.]

Nitrobenzoyl, like benzoyl, may replace an equivalent of hydrogen in ammonia, giving rise to *nitrobenzamine* $\left(N\begin{matrix}C_{14}H_4O_2\\NO_4\\H_2\end{matrix}\right)$. The best method of preparing this substance is to dissolve nitrobenzoate of ethyl $C_4H_5O\ C_{14}\begin{matrix}H_4\\NO_4\end{matrix}O_3$ [BENZOIC ACID], in alcohol, and to add ammonia in aqueous solution until the ether just begins to be precipitated. The mixture is placed in a stoppered bottle, in a warm place, and allowed to stand until a drop of it no longer gives a turbidity on falling into water. The product is then evaporated on a water bath, and the crystalline mass obtained, dissolved, and recrystallised from a mixture of alcohol and ether. It follows from the manner of the formation of nitrobenzamine that ethylamine, or ether, must accompany its synthesis. Whichever of these is formed, it is driven off from the water-bath. Nitrobenzamine melts below 212° Fahr.

Sulphobenzamine is ammonia containing an equivalent of benzoyl in which the oxygen is replaced by sulphur $\left(N\begin{matrix}C_{14}H_5S_2\\H_2\end{matrix}\right)$. It is formed by dissolving cyanide of phenyl in alcohol, adding a little ammonia and saturating with sulphuretted hydrogen. The liquid changes colour, and after standing some hours gives on evaporation a yellow flocculent precipitate which dissolves in boiling water, and deposits yellow silky needles of sulphobenzamine.

$$\underbrace{C_{12}H_5Cy}_{\text{Cyanide of Phenyl.}} + NH_3 + 3HS = \underbrace{N\begin{matrix}C_{14}H_5S_2\\H_2\end{matrix}}_{\text{Sulphobenzamine.}} + NH_4S.$$

In addition to these compounds, the following bodies also belong to the benzoic group:

Benzamic acid	$C_{14}H_6NO_3$, HO.	Benzilam	$C_{56}H_{18}N_2$
Benzosulphophenylimide	$N\left\{\begin{matrix}C_{12}H_5\ 2,SO_2\\C_{14}H_5O_2\\H\end{matrix}\right.$	Benzilimide	$C_{56}H_{22}N_2O_4$
		Benzonitraniside	$C_{24}H_{12}N_2O_8$
		Benzostilbine	$C_{62}H_{22}O_4$

For a description of these bodies, and for that of other compounds of the benzoic group, the reader is referred to Gerhardt's 'Traité de Chimie Organique,' tome iii.

BENZOIC SERIES. This series of organic compounds, one of the most numerously represented in organic chemistry, contains, according to Gerhardt's system of classification, the following eight groups, which see:

1. Phenylic Group.
2. Quinonic Group.
3. Benzoic Group.
4. Salicylic Group.
5. Anisic Group.
6. Cinnamic Group.
7. Naphthalic Group.
8. Indigotic Group.

BENZOICIN. [GLYCERIN.]

BENZOIN or BENJAMIN, a resinous substance, commonly but improperly termed a gum. It is extracted from the *Styrax benzoin*, which grows in Sumatra, by making incisions in the trunk. It hardens very quickly, and is imported in the state of brittle masses, which when fractured present a mixture of white, brown, and red grains, frequently as large as an almond. The fracture of benzoin is conchoidal, and the lustre is greasy; its specific gravity is from 1·063 to 1·092. Its smell is agreeable, resembling that of vanilla. It melts at a moderate heat, and yields benzoic acid, of which it contains about eighteen per cent.

According to the analysis of Unverdorben, benzoin contains, besides benzoic acid and a little volatile oil, three different resins. If benzoin be reduced to fine powder, and boiled in an excess of a solution of carbonate of potash, the benzoic acid and a resin are dissolved, which may be precipitated together by hydrochloric acid; when the precipitate is boiled in water, the acid and a little extractive matter are dissolved, and the resin is left, amounting to about 0·03 of that of the benzoin. This resin is of a deep brown colour; it is soluble in concentrated alcohol, but slightly so in ether and volatile oils, and insoluble in the oil of petroleum. This resin is a feeble negative electric; it does not decompose acetate of copper, but precipitates acetate of lead; carbonate of potash dissolves it but slowly. The compound of this resin with potash is soluble in anhydrous alcohol, but neither in ether nor in oil of turpentine. The aqueous solution is precipitated by chloride of ammonium. The greater part of benzoin is insoluble in solution of carbonate of potash, and it leaves a bright brown residue; from this, ether extracts one resin and leaves another. When the ether is evaporated, the resin dissolved in it remains. This latter resin is very soluble in alcohol and in oil of caraway, but not in oil of petroleum. It does not decompose acetate of copper; it dissolves readily in potash, and is not precipitated from solution by excess of it. Ammonia does not dissolve it; its compounds with earthy and metallic oxides are insoluble in ether.

The resin, which is insoluble in carbonate of potash, and remains unacted upon by ether, is brownish. It is soluble in alcohol, but not in the volatile oils nor ammonia. Potash dissolves it readily, but a great excess of the alkali precipitates the compound which is formed. This and the former resin, when precipitated by an acid from solution in potash, and exposed to the air while moist, are converted into the first resin, or that which is dissolved by carbonate of potash and alcohol. If the two last resins be subjected to dry distillation, they yield at first a volatile oil, which is very slightly empyreumatic, and which, like the oil of bitter almonds, is converted by the action of the air into benzoic acid.

Benzoin is employed in the preparation of benzoic acid; it is also used by perfumers.

BENZOIN, *Medical uses of.* The benzoin of commerce, sometimes called *Asa dulcis*, and vulgarly termed *Benjamin*, is obtained solely from the *Lithocarpus benzoin*, a tree growing in Sumatra (see Marsden's 'Sumatra,' i. 233), Borneo, Java, &c., from which it flows spontaneously in small quantity, but is obtained in greater abundance by making incisions in the stem beneath where the branches are given off, as soon as the tree has attained the age of five or six years. These incisions are repeated every year for about twelve years, when the tree becomes exhausted; each tree yields annually about three pounds. When it first flows from the tree it is soft, but gradually hardens by exposure to the air. The finest kind, which is whiter, and often in grains, flows from the youngest trees; this is called *Benzoe amygdaloides.* The

spontaneous produce of the tree during the first three years, is termed *head* benzoin; that obtained subsequently, *belly* benzoin; and at the end of ten or twelve years, the tree is cut down, the wood split up, and the scrapings collected and termed *foot* benzoin. These different sorts are of the relative value of 105, 45, 18. The benzoin which is met with in commerce is generally in cakes or fragments of different sizes, of a yellowish or fawn colour, covered with a whitish powder, intermixed with pieces of wood or leaves. When broken it exhibits a vitreous fracture, presenting portions of an almond-like shape, which are whiter than the surrounding portions, transparent, and friable. The more of these white pieces that occur in any specimen, the more it is esteemed; from exposure to the air they assume a yellowish hue. An inferior kind, called *benzoe in sortis*, is grayish brown, of a dull aspect, not transparent, with many portions of wood and bark intermixed with it. But the finest sorts in the European market are got from Siam; the produce, perhaps, according to the conjecture of Dr. Royle, of *Styrax Finlaysonianum*. "It occurs in tears, in irregular lumps, and in cubical blocks; but unlike the Sumatra sort, it never comes over enveloped in calico."—Pereira.

Benzoin is of the specific gravity of 1·063, is friable and easily powdered, during which process it causes sneezing, has an agreeable balsamic odour, and tastes at first sweetish, afterwards balsamic and stimulating. It melts at a moderate degree of heat, and evolves a white smoke and pleasant odour. The fumes which arise consist of benzoic acid, which may be easily condensed in a white flocculent mass, called flowers of benzoin. The odour is attributed by Dr. Thomson to the presence of a volatile oil, which accompanies the acid.

Benzoin is entirely soluble in alcohol and ether, but insoluble in fixed or volatile oils. Its alcoholic solution added to water becomes of a milky appearance.

Stolze analysed the white and brown kinds, and found them to consist of—

	White Benzoin, 100 parts.	Brown Benzoin, 100 parts.
Yellow resin, soluble in ether	79·83	8·80
Brown resin, insoluble in ether	0·25	69·73
Benzoic acid	19·80	19·70
Extractive	0·00	0·15
Impurities	0·00	1·15
Moisture and loss	0·12	0·17
A trace of volatile oil.		

Bucholz, John, and Kopp have analysed benzoin, but none obtained more than 14 per cent. of benzoic acid; the two former only 12. Wackenroder got only 9 per cent. of benzoic acid from Siam benzoin. 'Pharmac. Central-Blatt.,' fur. 1843, p. 336.

In its action on the system, benzoin resembles the other balsamic resins; being stimulant and exciting, as well as improving the quality of the secretions of the mucous membrane of the lungs. It was formerly employed as an expectorant in chronic catarrh and in asthma; and it may occasionally be serviceable when, from deficiency of nervous energy, expectoration is difficult, and an accumulation of mucus takes place in the lungs. It cannot fail, however, to prove hurtful if such accumulation arises from difficult circulation through the lungs, connected with organic disease of the heart, which is frequently the source of the spasmodic symptoms called asthmatic. It has also been recommended in cases of imperfect development of cutaneous eruptions, but it cannot be relied on in such cases.

In the present day it is chiefly employed to yield benzoic acid, and as an ingredient in pastilles, or to burn in censers in Roman Catholic churches. It enters into the composition of the *Tinctura benzoini composita*, the use of which is mostly confined to old ulcers; its application to recent wounds is very improper. [Balsams.] A solution of benzoin in alcohol, added to twenty parts of rose-water, forms the cosmetic called Virgin's milk.

BENZOINAM, $C_{56}N_2H_{24}O_2$. When a mixture of ammonia, alcohol, and benzoin is left in a closed vessel for some months, several new products are formed, amongst which is *Benzoinam*. It occurs in the form of small white needle-shaped crystals. It dissolves in acids, and is precipitated by alkalies.

BENZOINAMIDE = HYDROBENZOINAMIDE ($C_{84}H_{30}N_4$), is formed by exposing a mixture of benzoine and ammonia. It is a white, tasteless powder, and volatilises without decomposition.

BENZOLACTIC ACID. [Lactic Acid.]

BENZOLE ($C_{12}H_6$), or *hydride of phenyl* ($C_{12}H_5H$), in the impure state in which it occurs in commerce also called *benzine, benzoline,* and *benzine collas*, is a product of very frequent occurrence in the destructive distillation of many substances rich in carbon, such as the fats, fatty acids, coals, alcohol, &c. Benzole is best prepared when wanted in small quantities by heating benzoic acid with three times its weight of slaked lime. The distillate is separated from the water, agitated with potash, and rectified. Benzole also occurs in the liquid which accumulates in the condensers of coal-gas works. The more volatile portion of this liquid is re-distilled, the still being so arranged that the worm is heated to 212° Fahr., and the portions which condense at this temperature run back into the retort. On the second rectification, the worm is only heated to 176° Fahr., and the distillation is discontinued as soon as the contents of the retort reach 194°. The distillate so obtained is treated with dilute nitric and then with strong sulphuric acid, and submitted to a cold of 11° Fahr., at which temperature the benzole solidifies, and may be freed from the non-solidifying hydrocarbons by pressure.

Benzole is a colourless limpid liquid of agreeable odour. Specific gravity 0·9 at 32° Fahr., and 0·85 at 59° Fahr. Boiling point, 176° to 178° Fahr. Vapour density, 2·752. Point of congelation, 32°; point of liquefaction, 43° Fahr. Benzole is insoluble in water, but soluble in alcohol, ether, and acetone. It is a solvent for sulphur, phosphorus, and iodine to a small extent. It readily dissolves the fats, camphor, wax, caoutchouc, and gutta percha; the resins are dissolved by it with difficulty. Of the alkaloids, the four—quinine, morphine, strychnine, and cinchonine—are dissolved in the above order in respect to quantity; the last, cinchonine, being insoluble. Benzole, by itself, burns with a white but smoky flame, owing to the large quantity of carbon which it contains. Since however alcohol and benzole have nearly the same boiling point, a mixture of the two may be made to give a bright yet smokeless flame (1 vol. of benzole with 2 vols. of spirits of wine at 85 per cent. is a good proportion for this purpose). The illuminating power of ordinary coal-gas may be also much increased by passing it, previous to ignition, through benzole.

One, two, or three atoms of hydrogen in benzole may be replaced by bromine, the substitution products being *mono-*, *bi-*, and *tri-brombenzole* respectively. *Monobrombenzole*, $C_{12}\overset{H_4}{Br}H$, or the *hydride of monobromphenyl*, is obtained by conducting the vapour of bromine into a flask in which some benzole is heated to ebullition. As soon as two equivalents of bromine have been added, the contents of the flask are washed with aqueous potash, dried, and distilled. Monobrombenzole is a colourless liquid, which boils at 302° Fahr., and whose vapour density is 5·63. Fuming nitric acid converts it into *mono-bromnitrobenzole*, $C_{12}\overset{H_3}{Br}\overset{}{NO_4}H$, a solid volatile body, which melts at 194°. On leaving monobrombenzole in contact with bromine, hydrobromic acid continues to be evolved, and *bibrombenzole*, $C_{12}\overset{H_3}{Br_2}H$, separates out in large crystals, which are purified by solution in ether and spontaneous evaporation. Bibrombenzole melts at 192°, and boils at 426° Fahr.

If the bibrombenzole be boiled with alcoholic caustic potash, and the product precipitated with water and dissolved in ether, a solution is obtained from which *tribrombenzole*, $C_{12}\overset{H_2}{Br_3}H$, separates out as fusible, sublimable needles, soluble in alcohol and ether. The above compound may also be directly obtained, in combination with hydrobromic acid, by submitting benzole to the action of bromine in the direct sun-light. Its formula is $C_{12}\overset{H_2}{Br_3}H + 3HBr$. It is very insoluble in alcohol, ether, and water, not volatile without decomposition. Caustic lime converts it into tribrombenzole.

A similar chlorine compound, $C_{12}\overset{H_2}{Cl_3}H + 3HCl$, the *terhydrochlorate of trichlorbenzole*, is formed when chlorine is passed into benzole in the direct sun-light. This body, like the preceding, is a solid crystalline one, which may be purified by resolution in alcohol. It melts at 275° Fahr., and boils at 576°. On digestion with alcoholic caustic potash it is converted into *trichlorbenzole*, $C_{12}\overset{H_3}{Cl_3}H$, which is a colourless oil, of the specific gravity 1·457 at 44·6. It boils at 410° Fahr., and its vapour density is 6·37. The same substance is also obtained by the action of caustic lime or baryta upon chlorbenzole.

One or two atoms of hydrogen of benzole may also be replaced by the group NO_4, the resulting bodies being the *nitrobenzole*, $C_{12}\overset{H_4}{NO_4}H$, and *binitrobenzole*, or *dinitrobenzole*, $C_{12}\overset{H_3}{(NO_4)_2}H$, respectively. Nitrobenzole is prepared by gradually adding benzole to warm fuming nitric acid. On allowing the mixture to cool, the nitro-benzole separates out as an oil, which, after washing with water, is dried and rectified. Specific gravity, 1·209 at 59°. Boiling point, 427°. Vapour density, 4·40. It solidifies at 37·4. It is insoluble in water, soluble in nitric and sulphuric acids, as also in alcohol and ether. On account of its odour closely resembling that of oil of bitter almonds, and on account of its greater cheapness, it is used in perfumery as a substitute for the latter substance.

Dinitrobenzole is best prepared by dropping benzole into a hot mixture of equal parts of fuming nitric acid and oil of vitriol, allowing the mixture to boil for a few minutes, and then washing the crystals, which separate out on cooling in water, and recrystallising from alcohol. Dinitrobenzole crystallises in long needles, which melt at 212°, and are insoluble in water, but easily soluble in alcohol.

As benzole properly belongs to the phenyl group, the numerous derivations to which it and its nitro-substitution products give rise will be described under the head Phenyl.

BENZOLE LIGHT. [Lights, Artificial.]

BENZOLINE. [Amarine.]

BENZOLONE, $(C_{11}H_4O)$? When *Hydrobenzamide* $(C_{42}H_{18}N_2)_2$ is heated with potash till it becomes blackish-brown, this compound is formed. The mass, when washed with water, yields benzolone in the

form of small crystals. It gives a bright red colour when acted on by sulphuric acid.

BENZOPELARGONIC ACID ($C_{18}H_{17}O_3$, $C_{14}H_5O_3$), a composite anhydrous acid. [ANHYDRIDES.]

BENZOPHENONE. [BENZOIC GROUP].

BENZOSALICYLIC ACID ($C_{14}H_5O_3$, $C_{14}H_5O_5$). [ANHYDRIDES.]

BENZOVALERIC ACID ($C_{14}H_5O_3$, $C_{10}H_9O_3$). [ANHYDRIDES.]

BENZOYL, HYDRIDE OF ($C_{14}H_5O_2$,H), is the aldehyd of benzoic acid, and occurs in commerce as the *oil of bitter almonds*. The kernels of the fruits of the *Rosaceæ* and the allied families, contain amygdalin, together with emulsin. The latter substance in the presence of water acts as a kind of ferment upon the amygdalin, and converts it into the crude oil of bitter almonds. At the same time hydrocyanic acid is formed, which remains dissolved in the hydride of benzoyl. The best method of purifying the commercial oil consists in agitating it with a mixed solution of a ferrous and ferric salt in the presence of an alkali. The cyanogen is thereby converted into prussian blue, and remains behind on distillation. Pure hydride of benzoyl is a colourless highly refractive liquid of aromatic smell and burning taste. Its specific gravity is 1·05 at 58·3 Fahr., boiling point 354° It is soluble in 30 parts of water, and in all proportions in ether and alcohol. Ignited in the air it burns with a smoky flame. In the bodies of animals it is converted into hippuric acid.

Like all other aldehyds, hydride of benzoyl combines with the double sulphites of the alkalis. The bisulphite of ammonia compound has not been obtained in the pure state. The potash compound crystallises out on agitating the hydride of benzoyl with a solution of bisulphite of potash (of 1·25 sp. gr.). To purify this compound it is strongly pressed between bibulous paper, and recrystallised from boiling alcohol. The corresponding soda salt is prepared in a similar manner; its formula is $C_{14}H_6O_2NaO,2SO_2 + 2HO$. The salts of both potash and soda are readily soluble in water, and are easily decomposed by alkalis and dilute acids; in the former case monobasic sulphites being formed, in the latter alkali salts of the acid employed, sulphurous acid being liberated. In both cases the hydride of benzoyl is separated in the free state. The formation and decomposition of the alkali sulphites of hydride of benzoyl may be advantageously employed to purify the latter body completely.

Hydride of benzoyl quickly oxidises on exposure to the air, being converted into benzoic acid. This is especially the case in the presence of the alkalies which unite with and remove the acid as it is formed. In removing a portion of the oxygen from a confined portion of air, hydride of benzoyl converts the remainder into ozone. Nitric acid, or nitrate of potash, in the presence of strong sulphuric acid, converts hydride of benzoyl into the *hydride of nitro-benzoyl* $\left(C_{14}\overset{H_4}{N}O_4O_2H\right)$ which is molecularly symmetrical with the hydride. To prepare the hydride of nitrobenzoyl, one part by volume of hydride of benzoyl is agitated with 15 to 20 parts of a mixture of one part of fuming nitric acid and two parts monohydrated sulphuric acid. The heat evolved must be moderated. After complete mixture has been effected, three to four volumes of water are added which precipitate the nitro-compound as an oily liquid; this solidifies after standing a few days, and may be then purified by recrystallisation from boiling dilute alcohol. Hydride of nitrobenzoyl is a colourless solid of feeble odour; it melts at 115°, and is soluble in ether and alcohol. It is not volatile when heated alone, but in a stream of gas (hydrogen, nitrogen, carbonic acid) it may be distilled without residue. Like the hydride of benzoyl, the hydride of nitrobenzoyl combines directly with the bisulphites of the alkalis to form solid compounds, which are soluble in water and alcohol, and give up the organic hydride when warmed with dilute acids or alkalis. The alkali bisulphite salts of the hydride of nitro-benzoyl are less soluble than the corresponding combinations with the hydride of benzoyl; the soda salt contains eleven equivalents of water. [AMYGDALUS.]

BERBERINE ($C_{42}H_{19}NO_{10}$)? an alkaloid little known, found in the *Berberis vulgaris*, and in the root of the *Cocculus palmatus*. It crystallises in yellow silky needles.

BERGAMOT, ESSENCE OF, an essential oil, obtained both by pressure and distillation from the rind of the bergamot, the ripe fruit of the *citrus limetta:* it is limpid, yellowish, and fluid; that procured by pressure is not so fluid as that yielded by distillation, but its odour is more agreeable.

Essence of bergamot appears to consist of a mixture of two principles, one of which has the formula $C_{20}H_{16}$, whilst the second contains oxygen, and yielded to Soubeiran and Capitaine the following analytical results:—

Carbon	72·1
Hydrogen	10·8
Oxygen	17·1
	100·0

Placed in contact with anhydrous phosphoric acid, essence of bergamot forms *phosphobergamic acid*. The crude essence often deposits a camphor-like body called *bergaptene*, soluble in boiling water, in alcohol, and ether; its analysis leads to the empirical formula C_3HO.

The specific gravity of essence of bergamot is 0·888, its smell resembles that of oranges, and it is used as perfume; at a little below 32° Fahr. it becomes solid.

Vauquelin made a set of experiments to discover the effects that were produced by the mixture of alcohol and this oil, in order that the fraud which is commonly practised of mixing them might be detected. He found that 100 measures of alcohol dissolved 50 measures of oil, but that there were several anomalies in the proportions in which smaller quantities of alcohol dissolved the oil. The general results are: 1. That the oil of bergamot may contain 8 per cent. of alcohol, of the specific gravity 0·817, without its being perceptible when mixed with water. 2. That when it contains a greater quantity of it, the surplus separates, dissolving about one-third of its volume of oil. 3. That a small quantity of water mixed with the alcohol diminishes remarkably its action upon the oil; since alcohol of specific gravity 0·880 dissolves only 1-28th of its volume, while pure alcohol dissolves almost half its volume. 4. That when we mix alcohol with a volatile oil, a mutual exchange takes place between the two fluids, the relation of which must vary with the purity of the alcohol; this last dissolves the oil, whilst the oil absorbs the alcohol. 5. That when we mix alcohol of specific gravity 0·847, for example, with oil of bergamot, which is, 0·856, the alcohol sinks to the bottom, and the oil swims upon it: this depends upon the oil absorbing a part of the pure alcohol, and thus rendering the remainder more dense, while it becomes itself more light. 6. That there takes place a kind of decomposition of the water and alcohol by the oil; from which it may be suspected that, if we were to mix a small quantity of diluted alcohol with a large quantity of volatile oil, the water would be separated, and be precipitated alone to the lower part of the vessel. Hence we learn that the dealers in perfumes may introduce 8 per cent. of alcohol into them without our being able to detect the fraud by the ordinary means; but it may be discovered by the assistance of the spirit hydrometer, as the density will be diminished by about 1-100th part. Sulphuric ether does not act on the oil of bergamot like alcohol; it unites with it in all proportions, and the fluids do not afterwards separate.

BERGAPTENE. [BERGAMOT, ESSENCE OF.]

BERLIN WORK. [EMBROIDERY.]

BERME, in fortification, is a kind of terrace formed at the foot of a parapet on the exterior side. It is generally in a horizontal position, about the level of the natural ground, and it separates the escarp, or that side of the ditch which forms the face of the rampart, from the outward slope of the parapet.

The berme prevents the earth constituting the parapet, when that work is damaged by rain or otherwise, from falling into the ditch. Its breadth is usually from two to three feet, and the ditch being at that distance from the foot of the parapet, the pressure of the latter against the escarp wall is in some measure diminished, a circumstance of considerable importance when the soil has not much tenacity. If the berme on the exterior of a bastion or ravelin is from 10 to 15 feet broad, it takes the name of *chemin des rondes*, and serves as a convenient post for sentries and as a path for the officers going their rounds to see that the troops are on the alert. It may also be useful as a station for the defenders, when opposing any attempt at an open assault by preventing the enemy from planting his scaling-ladders against the face of the escarp. Communications to the berme from the interior of the work are by passages through the parapet. It should be protected on the exterior by a hedge or a low wall, and the latter might be pierced with *loop-holes* for the defence of the ditches and covered-way.

Vauban, in his treatise on the defence of places, ascribes great importance to the *chemin des rondes*. He observes, that the ruins of the parapet, produced by firing at it from a distance, being retained on this part of the work, increase the height of the escarp, and thus compel the enemy, if he would form a practicable breach, to establish his batteries on the crest of the glacis, in order that he may be enabled to fire at and breach the wall near its foot. A broad berme is however liable to some objections, for its protecting wall is easily destroyed by the enemy's batteries, and it entails the rampart being wider than is in some cases convenient. Moreover, if the enemy should succeed in gaining it by an escalade, he might form there in good order, and mount the parapet in force. It must inevitably happen, also, that the missiles which the defenders might attempt to roll over the parapet upon the assailants while in the ditch would be intercepted by the berme. Vauban himself states that, at the siege of Gravelines, the besiegers were enabled to blow up the rampart by a mine; the *chemin des rondes* and part of its wall, which had been accidentally left standing, preventing the loaded shells, masses of stone, &c., which were thrown by the defenders over the parapet from falling near the miner who was employed in piercing the escarp. It is evident however that this rampart must have been entirely unflanked by the collateral works of the place.

The position of the *chemin des rondes* is indicated by the unshaded space on the exterior of the parapet along the faces and flanks of the work V, which is given in the article BASTION.

BERNARDINES, a branch of the Benedictine Order of Religious, more frequently called Cistercians. Their name of Bernardines was derived from St. Bernard, abbot of Clairvaux, or Clareval, in the diocese of Langres, about A.D. 1115, who was a great promoter of their order. [BERNARD, ST., in BIOG. DIV.] They were called Cistercians from Cistertium or Cîteaux, in the bishopric of Châlons in Burgundy, where the order was begun in the year 1098 by Robert abbot of

Molesme in that province, but brought into repute by Stephen Harding, an Englishman, third abbot of Citeaux, who is therefore reckoned the principal founder. Their monastery and church here have been destroyed, and even of the ruins there are hardly any remains. They were also called White Monks from the colour of their habit. Fuller, in his 'Worthies,' book iii., probably errs, when he makes the Bernardines to be a stricter order of Cistercians.

The monasteries of the Bernardine or Cistercian Order, which became very numerous in a short time, were generally founded in solitary and uncultivated places, and were all dedicated to the Virgin Mary. It was a rule with the Cistercians not to allow another house, even of their own order, to be built within a certain distance. Stevens, in his continuation of Dugdale's 'Monasticon,' vol. ii., says, if we may believe the historians of this order, they had in all 6000 houses. The 'Histoire des Ordres Monastiques,' says, that within fifty years of its institution there were 500 abbeys of this order, and within a century they are stated to have had 1800. Their wealth was so great, that St. Bernard, the reformer of the order, states, that "he knew several abbots, each of whom had more than sixty horses in his stable, and such a prodigious variety of wines in his cellar that it was scarcely possible to taste the half of them at a single entertainment." (Mosheim's 'Ecclesiastical History,' Maclaine's edit., cent. xii. part ii., note.)

One of their most famous establishments in England was the abbey of Buckfastleigh, in Devonshire, some of the remains of which still exist, which was re-established as a Benedictine immediately after the Conquest. Here the monks, however, performed good service by introducing great agricultural improvements, and to the exertions of the monks of another of their abbeys at Birkland, founded in the 13th century, who attended particularly to their orchards, and grafted their trees with the choicest speciments from Normandy, the Devonshire cider may owe its repute if not its origin. (Dr. Oliver's 'Monasticon Diœcesis Exoniensis,' 1846.) Manning and Bray, however ('History of Surrey'), state that the monastery of Waverley in that county, was the first house of the Cistercian Order established in England, although precedence was for a while claimed by the abbey of Furness in Lancashire. The 'Annals of Waverley,' printed by Gale, give a minute account of the dispute. The abbot of Waverley had precedence as well in the chapters of the Cistercian abbots through England, as a superiority over the whole order in this country.

In the 26 Hen. VIII. the number of Bernardine or Cistercian abbeys in England, of which thirty-six were among the greater monasteries, amounted to seventy-five, besides twenty-six Cistercian nunneries. Of the latter, one only was endowed with more than 200*l.* per annum. The total revenue of the Cistercian houses in England amounted to 18,691*l.* 12*s.* 6*d.*

Stevens, in his work already quoted, vol. ii. p. 23, has translated a long history 'Of the Original and Progress of the Order of Cistercians,' from the French 'Histoire des Ordres Monastiques,' &c., tom. v. Dugdale and Stevens, between them, have printed the rules and regulations of this order, with the various bulls of confirmation and privilege granted to it by different popes. Stevens has likewise given a list of the learned men of the Order of the Bernardines or Cistercians in England, thirty-six in number. St. Bernard's College in Oxford (since refounded as St. John's College) was founded by Archbishop Chichele, in 1437, for scholars of the Cistercian Order who might wish to study in Oxford, but had no place belonging to their order in which they could associate together, and be relieved from the inconveniences of separation in halls and inns, where they could not keep up their peculiar customs and statutes. The figure of St. Bernard still stands in a niche in the upper part of St. John's College tower.

St. Alberic, who became abbot of Citeaux in 1099, drew up the first statutes of this order. The Harleian Manuscript 3708 (British Museum), a volume of the 14th century, contains another body of statutes for the order, compiled in the years 1289 and 1300.

The habit of this order was a white cassock with a black hood and scapulary, and a girdle of black wool round the waist; in the choir they wore a white cowl, and over it a hood with a rochet; when they went abroad they wore a cowl and great hood all black. The dress of the lay-brethren was of a dark colour, and their hood like that of the monks except in its hue. The Cistercian nuns wore a white tunic, black scapular, black girdle, and in the choir either cowls or mantles. The dress of the lay-sisters was of a dark colour; that of the noviciates white; and all wore a black veil and white wimple. (Fosbroke's 'British Monachism,' 3rd edit., 1844.)

The abbot of Citeaux in Burgundy continued to be the superior general and father of the whole Bernardine or Cistercian Order till the French Revolution.

The Reformation lessened their numbers in Germany. Attempts at removing the corruptions which wealth introduced, split the order into several branches; the various political changes in Germany have also diminished the number of their establishments, but several yet exist in Italy, Poland, Germany, and France. In the latter country, the most noticeable is that of La Trappe, of which a branch has been settled in England.

BERYL (*Rhombohedral Emerald; Aquamarine; Smaragd*), a precious stone found in primary rocks in Grenada, Salzburg, Siberia, Upper Egypt, Hindostan, and North America. It is of various shades of green and blue, and is distinguished as containing a considerable amount of the rare earth *glucina*. A specimen of Siberian beryl, analysed by Klaproth, contained the following substances:—

Silica	66·45
Alumina	16·75
Glucina	15·50
Oxide of Iron	·60
	99·30

BETA-ORSELLI ACID. [Lichens, Colouring Matters of.]

BETA-ORCEIN. [Lichens, Colouring Matters of.]

BETH. [Beit.]

BETROTHMENT. We sometimes hear of parties being *betrothed* to each other, which means that each has pledged his or her *troth* or *truth* to the other, to enter at some convenient time, fixed or undetermined, into the state of matrimony. It now has seldom any other meaning than that the parties have engaged themselves privately, sometimes, though it is presumed very rarely, in the presence of one or more friends who might, if necessity of doing so arose, bear testimony to such an engagement having been entered into. Even the rustic ceremonies which heretofore were in use to give some kind of formality to such contracts seem almost to have fallen into entire disuse. In ancient times however there were engagements of this kind of a very formal nature, and they were not thought unworthy the notice of the great legislators of antiquity. In the laws of Moses there are certain provisions respecting the state of the virgin who is betrothed. In the Roman law, the "sponsalia," or betrothment, is defined to be a "promise of a future marriage." It could take place after the parties were seven years of age. There was no fixed time after betrothment at which marriage necessarily followed, but it might for various reasons be deferred for several years. The sponsalia might be made without the two parties being present at the ceremony. ('Dig.' xxiii. t. i.)

The canonists speak of *betrothing* and of *marrying*, describing the former as being sponsalia, or espousals, with the *verba de futuro*, the latter with the *verba de præsenti*. In England, there is no doubt that formal engagements of this kind were usual down to the time of the Reformation. One class of documents which have descended in families who have been careful in the preservation of their ancient evidences, are marriage contracts, which are generally between parents, and set out with stating that a marriage shall be solemnised between certain parties when they attain to a certain age, or at some distant period, as after six months or a year; and amongst the terms of the contract it is not unusual to find stipulations respecting the apparel of the future bride, and the cost of the entertainment which is to be provided on the occasion. When these contracts were entered into by the parents, there is reason to believe that the younger parties solemnly plighted their troth to each other.

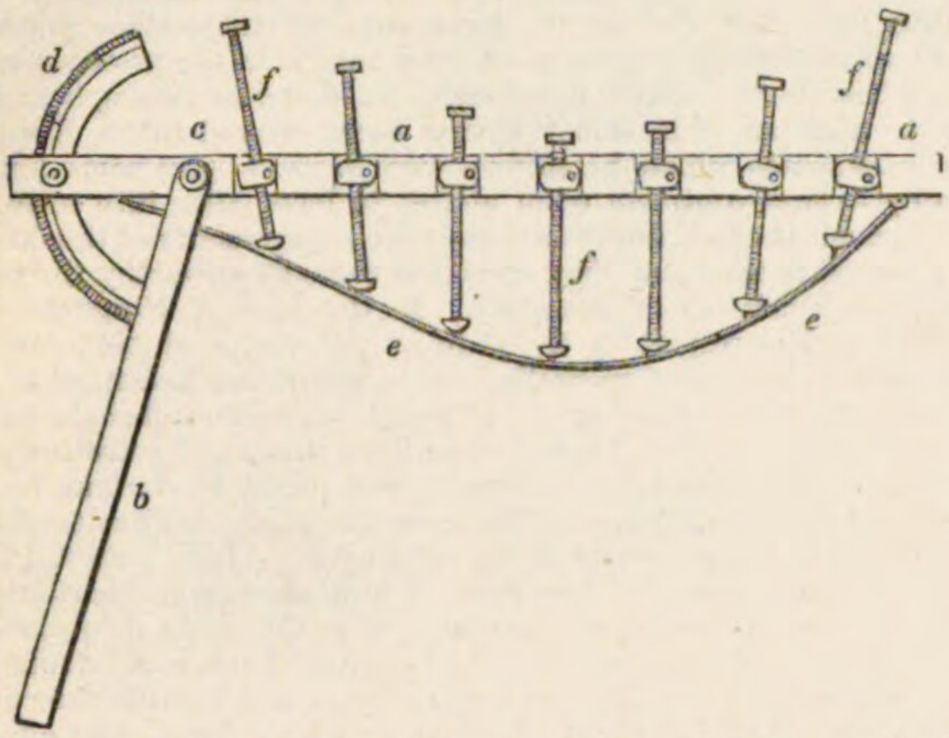
The late Mr. Francis Douce, who was very learned in all matters relating to the popular customs of our own and other nations, describes the ceremony of betrothment ('Illustrations of Shakspeare and of Antient Manners,' vol. i. p. 108) as having consisted in "the interchangement of rings—the kiss—the joining of hands, to which is to be added the testimony of witnesses." In France, where the ceremony is known by the name of *fiançailles*, the presence of the curé, or of a priest commissioned by him, was essential to the completeness of the contract. In England, such contracts were brought under the cognizance of the ecclesiastical law. Complaints are made by a writer about the time of the Reformation, cited in Ellis's edition of Brand's 'Popular Antiquities,' that certain superstitious ceremonies had become connected with these engagements; but Mr. Douce was unable to find in any of the ancient rituals of the Church any prescribed form in which this kind of espousals were to be celebrated. The Church however undertook to punish the violation of the contract. Whoever, after betrothment, refused to proceed to matrimony, *in facie ecclesiæ*, was liable to excommunication till relieved by public penance. This was taken away by stat. 26 Geo. II. c. 33, and the aggrieved party was left to seek his remedy by an action at common law for breach of promise of marriage. (Blackst. 'Comm.,' Dr. Kerr's ed., v. i. p. 452.)

The northern nations, including the English and the Scotch, called this ceremony by the expressive term, *hand-fasting*, or *hand-fastning*. In Germany, the parties are called respectively "bride" and "bridegroom," "bräut" and "bräutigam," from the time of the betrothment (verlobung) *until* the marriage, when these designations cease.

BETULIN ($C_{40}H_{33}O_3$?), a resinoid body obtained from the bark of the birch. It is colourless, insoluble in water, slightly soluble in alcohol, and very soluble in ether. It fuses at 392° Fahr., and may be sublimed in a stream of air.

BEVEL, or BEVIL, is the name applied both to the oblique angle formed by two surfaces which meet at either more or less than a right angle, and to the instrument employed by carpenters and joiners for taking and transferring such angles. The common carpenter's bevel consists of a straight wooden stock, mortised at one end to receive a thin blade, which is usually formed of steel, and attached to the stock by a pin in such a way that it may be turned to any required angle, and secured by a tightening screw. This kind of bevel may be described as an adjustible T-rule, the transom of which may be placed at any required angle with the stock. In some cases the pin or pivot which connects the blade with the stock passes through a slot or long

opening in the blade or transom, so that its arms may be made of unequal length. Hebert describes, in the 'Engineer's and Mechanic's Encyclopædia,' an instrument of the bevel kind for gauging, and transferring to work or paper an oblique angle of which one side is curved. It consists of two rulers, *a* and *b*, pivoted together at *c*, and capable of being set to any angle by means of the brass arc *d*, which is attached firmly to the ruler *b*, and passes through a mortise or slit in *a*, in which it may be secured at any point by means of a binding screw. The adaptation of the instrument to a curved surface is provided for by a flexible blade or riband of steel, *e*, secured to the ruler *a* at one end, but capable of being made to assume and retain any simple curve by means of the series of screws marked *ff*, which pass through nuts or mortises attached to the ruler *a*, and press against the steel riband by a kind of swivel-joint, which provides for the various angles of contact formed by the riband and the screws.



Where many articles have to be worked to the same angle, it is desirable to use a fixed bevel, made to the required angle, especially where one or both of the limbs are curved. When the interior angle of the bevel is that used by the workman, such an instrument is sometimes called a *joint-hook:* a familiar instance of its use in this way is in working the intradoses and radiating beds of arch-stones, which, for circular arches, will be alike in every part of the arch.

BEY. [Beg.]

BEZA'S CODEX, a celebrated manuscript, containing the Four Gospels and Acts of the Apostles, written in Greek, with a corresponding Latin text on every opposite page. Of the Greek text we shall speak more particularly presently. The Latin version is believed to be the 'Vetus Italica,' the old Italic, before it was corrected by St. Jerom.

This singular manuscript was presented to the university of Cambridge by Theodore Beza in the year 1581, whence it has its name of 'Codex Bezæ,' and is sometimes cited as 'Codex Cantabrigiensis.' It is a thick quarto volume, written upon vellum, in uncial letters of the square form, that is, in large capitals quadrated, as distinguished from the sharper uncials. The letters, in some places, particularly in the beginning of the first leaf, are scarcely legible. The gospels are placed in the usual order of the Latin manuscripts,—Matthew, John, Luke, Mark. This codex has no stops, marks of aspiration, or accents.

There are various chasms in this manuscript, which, both in the Greek and Latin texts, have been supplied at later periods. The defective passages in the Greek are Matthew i. *v.* 1 to 20; vi. *v.* 20, to ix. *v.* 2; xxvii. *v.* 2 to 12; John i. *v.* 16 to iii. *v.* 26; Acts viii. *v.* 29 to x. 14; xxi. v. 2 to 10, and 15 to 19; xxii. *v.* 10 to 20; lastly, xxii. 29 to the end of the MS. In the Latin version the chasms are Matthew i. *v.* 1 to 12; from *v.* 8 in chap. vi. to viii. 27; from xxvi. 65 to xxvii. 2; from John i. 1 to iii. 16; Acts viii. 19 to x. 4; xx. 31 to xxi. 3, and 7 to 11; xxii. 2 to 10; and lastly, from Acts xxii. 20 to the end.

In the year 1787, immediately after the appearance of the New Testament of the Alexandrian Manuscript, published by Dr. C. G. Woidè, the university of Cambridge appointed Dr. Thomas Kipling, late fellow of St. John's College, and Deputy Regius Professor of Divinity, to edit this their highly-prized manuscript in fac-simile: that is, as far as metal types could be made to represent it, for a real absolute fac-simile can be obtained only by engraving. It appeared in 1793, in two volumes folio, edited with fidelity, accompanied by a preface of twenty-eight pages, and followed by twenty-four pages of notes, entitled, 'Codex Theodori Bezæ Cantabrigiensis, Evangelia et Apostolorum Acta complectens, quadratis literis Græco-Latinus: Academiâ auspicante, venerandæ has vetustatis reliquias, summâ quâ potuit fide, adumbravit, expressit, edidit, Codicis historiam præfixit, notasque adjecit Thomas Kipling, S.T.P. Coll. Div. Joan. nuper socius.'

Dr. Kipling, in his preface, endeavours 1st, to establish the high antiquity of his MS.; 2ndly, he points out its peculiar character and excellence; 3rdly, he traces its migrations; and lastly, he describes its form.

It is allowed by all palæographists that Beza's MS. is one of the most ancient of its kind. The Rev. Henry Alford, in his edition of the Greek Testament (1856), says, "the general opinion now is, that it was written in the latter end of the 5th or 6th century." Wetstein and J. D. Michaelis deemed it much older; and Dr. Kipling was of opinion that it was more ancient than the Alexandrian MS., and must have been written in the 2nd century. His conjecture is founded on these circumstances, that it wants the doxology at the end of the Lord's Prayer, and has the Ammonian sections without the Eusebian canons. That the doxology is an interpolation there can be little doubt; but that the want of it in a MS. is a proof of the high antiquity of that MS. cannot so readily be admitted. If the writer of Beza's MS. were a Latinist, he might leave out the doxology in his Greek copy, because it was not in his Latin copy; or his Greek copy might have been one of those which wanted the doxology. The argument derived from the entire omission of the Eusebian canons, and from the Ammonian sections being added by a posterior writer, is more specious. Dr. Kipling hence infers that the text of the MS. was written antecedently to the date of the Ammonian sections, and these before the Eusebian canons appeared. Ammonius lived in the 3rd, Eusebius in the 4th century: the Ammonian sections in Beza's MS. are much posterior to the text, and are without the canons of Eusebius; therefore he considers it highly probable that those sections were added to the MS. before the *fourth*, and that the manuscript itself was written before the *third* century.

As to the nature and excellence of the Beza manuscript, great diversity of opinion subsists. Antony Arnauld ('Dissertation Critique touchant les Exemplaires, sur lesquels M. Simon pretend que,' &c., 8vo. Col. 1691) insisted that it was a forgery of the 6th century, and therefore unworthy of credit; and his chief argument was, that it has certain additions or interpolations which are not found in the copies anterior to that period; such as that in Matthew xx. 28, ὑμεῖς δὲ ζητεῖτε, &c.; that in Luke vi. 5, τῇ αὐτῇ ἡμέρᾳ, &c. This reasoning would be solid, if the assumption were just; namely, that these and similar interpolations were not found in any other MS. before the 6th century. Dr. Kipling draws from the same circumstance a very different conclusion: he thinks that the aforesaid additions are proofs that either the Beza MS. or its archetype must have been written before Jerom corrected the text of the New Testament, because they are not in his version. Bengel supposes this MS. to be of British origin from its great conformity with the Anglo-Saxon version, and to have been reformed, or rather corrupted, according to the Italic version. To this argument it is answered, that the Beza MS. resembles the Syriac version as much as it does the Italic and Anglo-Saxon. Michaelis, in his account "of the manuscripts that have been used in editions of the Greek Testament" ('Introd. to the New Test.' 8vo. Cambr. 1793, vol. ii. p. i. pp. 228, 229) is of this opinion, in which he is corroborated by Professor Storr, who, in the eighth section of his 'Observationes super Novi Testamenti Versionibus Syriacis,' produces various examples in which the Syriac version coincides with the 'Codex Cantabrigiensis,' and at last conjectures that the latter has, in some cases, been improperly altered from the former, through a mistake of the Syriac text. Dr. Alford says, "the text is a very peculiar one, deviating more from the received readings and from the principal MS. authorities than any other. It appears to have been written in France, and by a Latin transcriber ignorant of Greek, from many curious mistakes which occur in the text and version attached. It is closely and singularly allied to the ancient Latin versions, so much so, that some critics have supposed it to have been altered from the Latin, but apparently without reason. Its peculiarities are so great, that in many passages, while the sense remains for the most part unaltered, hardly three words together are the same as in the commonly received text. And that these variations often arise from capricious alterations is evident from the way in which the Gospels, in parallel passages, have been more than commonly interpolated from one another in this MS. The concurrence with the ancient Latin versions seems to point to a very early state of the text, and it is impossible to set aside the value of it as an index to its history; but in critical weight it ranks the lowest of the four leading MSS." (that is, the Codex Alexandrinus, now in the British Museum; the Codex Vaticanus, in the Vatican Library; the Codex Regius Parisiensis, in the Imperial Library at Paris; and that of Beza, of which we have just treated.)

In noticing what Dr. Kipling calls the "migrationes," or peregrinations of the Codex Bezæ, he gives it as his opinion, from internal evidence, that it was written in Egypt: others have been persuaded that it was written in the West, not by a Greek, but by a Latinist. By what means this manuscript passed to France is unknown. Beza, who presented it to the university of Cambridge, had himself received it about nineteen years before. He states it to have been found, in 1562, in the monastery of St. Irenæus at Lyon. Beza was at that time resident at Geneva. It has been supposed by some critics to be the manuscript which was produced in the Council of Trent, in 1546, by the bishop of Clermont, and which Drathmurus mentions 400 years before that council; but this is mere conjecture, and scarcely amounts to a probability.

BEZANT, a gold coin struck at Constantinople by the emperors of that city, anciently called Byzantium. William of Malmesbury says expressly, 'Constantinopolis primum Byzantium dicta. Formam

antiqui vocabuli præferunt imperatorii nummi Bizantini vocati." ('Script. post Bedam,' edit. Saville, fol. 76 b.) This coin was called byzant, besans, bezantus, byzantius, byzantinus, byzanteus, and bixantius. The coins were in fact aurei, but as they were the only gold coin current in Europe for a considerable time, they went by the name of bezants among foreigners.

The Moors of Spain stamped also a gold coin called byzantius massamutinus. There was likewise the byzantius saracenatus, or saracenicus, struck by the sultans of Iconium in Lesser Asia; and byzantii melechini, so called from being coined at Malines in Flanders.

These bezants were not always of the same weight, fineness, or value, since we find them described as *aurei byzantii; aurei boni byzantii;* and *auri optimi byzantii.* Ducange quotes this last expression from a charter of the year 915. (Apud Ughellum, tom. i. pp. 853, 960.) The aurei, or bezants, of Constantine, were to be of the weight of seventy-two to the pound of gold.

Byzantii albi, seu argentei, white or silver bezants, also occur in the 'Constitutiones Odonis legati Apost. in Cypro,' an. 1248. Ducange quotes a charter of 1399, which speaks of white bezants of Cyprus. They likewise occur in a bull of Pope Gregory IX. (Apud Ughellum, tom, vii. p. 60.)

The Moorish bezants are sometimes called in old writers marabotini, or maurabotini. They are mentioned by this name in Matthew Paris, 1176. ('Hist. Major.' edit. 1684, p. 110.) See also Ralph de Diceto under the year 1177. ('Script.' x. Twysd. col. 598.) From Ducange we learn that "Morabotini boni Alfonsini, auri fini et ponderis recti," frequently occur in Aragonese charters towards the close of the 13th century. The Moors in Spain had also gold trientes, or the third of a bezant, but all these coins were of very limited circulation.

Camden, in his 'Remains concerning Britain,' noticing the coined and other money in use among our Saxon ancestors, says, "Gold they had also, which was not of their own coin, but outlandish, which they called in Latin bizantini, as coined at Constantinople sometimes called Bizantium, and not at Besançon in Burgundy. This coin is not now known, but Dunstan, archbishop of Canterbury (as it is in the authenticated deed), purchased Hendon in Middlesex of King Edgar to Westminster for two hundred bizantines. Of what value they were was utterly forgotten in the time of King Edward III.; for, whereas the bishop of Norwich was condemned to pay a bizantine of gold to the abbot of St. Edmundsbury for encroaching upon his liberty (as it was enacted by parliament in the time of the Conqueror), no man then living could tell how much that was, so as it was referred to the king to rate how much he should pay."

In Domesday Book no mention whatever occurs of the bezant; but it occurs twice as a denomination of money, in the Winton Domesday of the year 1148, and several times in the Boldon Book, a survey of the palatinate of Durham made in 1183; both printed among the 'Supplementary Records' to the Great Domesday. The monks of Oseney, in consideration of the manor of Hampton-Gay in Oxfordshire, in the 6th of King Stephen, gave ten marks of silver to Robert de Gait, and one bezantine to his wife. (Kennet's 'Parochial Antiquities of Oxfordshire,' edit. 1695, p. 97.) Madox in his 'History of the Exchequer,' says, that in Henry II.'s time, Cressalin the Jew of Winchester, was amerced one hundred marks, and he paid instead thereof, one hundred bezants, which were accepted by the king, *mera gratiâ.* ('Mag. Rot.' Henry II. rot. 10, art. 'Sudhantescira.') Madox also says ('History of the Exchequer,' p. 711), that in the 17th year of King John, 10*s.* of Venetian money, and two bezants, were used at the Exchequer for counters: the Venetian shillings valued at 15*s.* and the two bezants at 3*s.* 6*d.* These of course were silver bezants. From the narrative of William de Braose's treasons (recorded in the Black and Red Book of the Exchequer) against King John, it is clear that silver bezants were in use in that reign; for when Maud, Braose's wife, was to make the first payment of a fine of 40,000 marks, which she and her husband had consented to pay on being restored to the king's favour, she told the justiciary, and the rest who were sent to distrain upon their goods, that they must expect nothing, she having no more money in her purse than twenty-four marks of silver, twenty-four shillings of bezants, and fifteen ounces of gold. (See Dugdale 'Baron.' tom. i. pp. 416, 417.) John of Glaston, in his 'Chronicle' (vol. i. p. 224) informs us that Michael, abbot of Glastonbury, dying 1253, left to his successor "quadraginta bisancios et viginti libras sterlingorum." Chaucer names the "besaunt" in the 'Romaunt of the Rose,' and Wycliffe, in his translation of the New Testament (Luke, c. xv. v. 8, 9), uses the term "besauntis" for the ten pieces of money in the parable.

The probability seems to be that the bezant of gold was current in England, if not from the 9th, certainly from the 10th, century, till the time of Edward III., when the coinage of the English noble drove it out of use.

The Constantinopolitan bezant was the coin which we still see in our cabinets in gold, in the form of an umbo, or hollow dish, frequently bearing the portrait of our Saviour. The weight of one of those of Alexius Comnenus I., who reigned from 1081 to 1118, is seventy grains. The Moorish bezants were flat. The Constantinopolitan bezant seems to have been generally of about the value of a ducat, or nine shillings. The name was probably given in the middle ages to the gold coins of most countries. Cotgrave says that Henry II. of France coined bezants.

The white, or silver bezant, in the 16th year of Stephen, according to an instrument quoted in Kennet's 'Parochial Antiquities,' edit. 1695, p. 10, was of the value of 2*s.* No silver bezant is at present known to exist, at least under that denomination, in the cabinets of our collectors: but Constantinopolitan coins of silver, of the same size and form with the gold bezants, are found in cabinets, of the 12th and later centuries: they usually weigh about forty or forty-three grains.

Banduri and other writers call both the gold and silver coins of Constantinople, which we have described, *Nummi Scyphati.*

Camden ('Remains,' p. 236), says, that in the court of England, the piece of gold valued at 15*l.*, which the king was anciently accustomed to offer on high festival days, was called a bizantine: "which anciently was a piece of gold coined by the emperors of Constantinople; but, afterward, there were two," probably meaning bars, "purposely made for the king and queen, with the resemblance of the Trinity, inscribed 'In honorem sanctæ Trinitatis,' and on the other side the picture of the Virgin Mary, with 'In honorem sanctæ Mariæ Virginis;' and this was used till the first year of King James, who, upon just reason, caused two to be new cast, the one for himself, having on the one side the picture of a king kneeling before an altar, with four crowns before him, implying his four kingdoms, and in the circumscription, 'Quid retribuam Domino pro omnibus quæ tribuit mihi?' On the other side a lamb lying by a lion, with 'Cor contritum et humiliatum non despiciet Deus.' And in another for the queen, a crown protected by a cherubim, over that an eye, and 'Deus' in a cloud, with 'Teget alâ summus;' on the reverse a queen kneeling before an altar, with this circumscription, 'Piis precibus fervente fide humili obsequio.'"

By the treaty for the deliverance of the French king St. Louis, and the other prisoners made at the battle of Mansoura and elsewhere, between the commissioners of his majesty and the sultan of Babylon, it was agreed that the king should pay to the sultan 1,000,000 (dix cens mils, Joinville says) gold bezants, which were then worth, according to the recital of the Sieur de Joinville, 500,000 livres. The sultan afterwards remitted a part, on the king's frank agreement to the sum proposed, and it was thereupon reduced to 800,000 gold bezants. (Joinville, 'Histoire de St. Louis,' ed. Michel, p. 104.)

Bezant is represented in heraldry by round pieces of gold without any impression, and are held to signify the coins by which the stipends of the higher soldiers of the army in the holy wars are supposed to have been paid. They are, with us, always emblazoned gold, but the foreign heralds make them both gold and silver. In English heraldry when the figures are blazoned argent they are called plates.

BEZOARIC ACID. [ELLAGIC ACID.]

BEZOARS. [ELLAGIC ACID.]

BEZOARS. The most probable etymology of the word bezoar is from the Persian *Pâd-zahr,* that is, "expelling poison, the expeller of poison." The stone bears this and other designations of similar import in Persian; for example, *Bâd-zahr,* which seems to be a corruption of *Pâd-zahr.* The word *pâd* means "relieving, curing, removing (disease)," and *zahr* is "poison." Bezoars are substances found in various parts, but chiefly in the intestines, of land animals, and which were regarded as antidotes to all poisons, as well as supposed to possess other extraordinary virtues. Hence any substance which possessed, or was thought to possess, important qualities, was termed *bezoardic,* to indicate its value. Bezoars are either natural or artificial; but even the natural ones, being the result of disease, are not invariably met with in the animals which produce them. Their rarity, as well as the preternatural virtues ascribed to them, contributed to make them prized; on which account they have sometimes been sold for ten times their weight of gold. Those which were most esteemed came from the East, and were the earliest used. The most highly-valued of these was obtained from the stomach of the *Capra Aegagrus,* or wild goat of Persia. This was called by way of eminence *Lapis Bezoar Orientalis.* The greater number of bezoars are procured from ruminating animals, and in many instances they are nothing more than some portion of their food agglutinated into a ball by the secretions of the intestinal canal. Similar formations are sometimes found in the human stomach or intestines, especially in persons who live much upon vegetable or farinaceous food. (See Monro, 'On the Morbid Anatomy of the Gullet,' &c.) The bezoars from the west, called also American, are chiefly obtained from the *Auchenia Lama* and *Auchenia Vicuña,* Illig. These have been analysed by Proust, and found chiefly to consist of phosphate of lime. (See 'Ann. de Chimie,' vol. i. p. 197.) The oriental and some other bezoars were analysed by Fourcroy and Vauquelin. (See 'Ann. du Muséum d'Hist. Nat.' i. 93, iv. 334.)

Bezoars, though still esteemed in the East, have long fallen into merited disuse in Europe. Various artificial bezoars were often fraudulently substituted for the genuine; but these are not to be confounded with certain metallic preparations, chiefly of tin, silver, mercury, and lead, the composition of which was well known, and only designated bezoars from their power in curing diseases; these, if employed in the present day, are designated by other names, and will be noticed under the heads of the metals and their preparations.

The *Bezoardicum animale* was the name given to the heart and liver

of vipers, which, with other disgusting articles, were once used in medicine, but are now laid aside.

BIBLE, Βιβλία, Biblia, meaning *books*, is the name which was given in the 5th century by Chrysostom to the collection of sixty-six writings which are recognised by Christians as divine. To these sixty-six sometimes are erroneously joined about fourteen apocryphal writings, so that the total number amounts to about eighty, of which thirty-nine are in the Old, and twenty-seven in the New Testament.

Before Chrysostom, the more complete expressions for Bible were *βιβλία θεῖα, books divine;* or *ἱερὰ γραφὴ, θεῖα γραφὴ, ἁγία γραφὴ*, sacred writings, &c.

"Independently of all consideration of its religious advantages, no book has conduced more than the Bible to the high cultivation and moral advancement of the human mind. The labour bestowed by so many of the learned upon the just interpretation of this inestimable book is of itself an attestation of its worth, and countenances the supposition that Divine Providence has appointed it for the attainment of great designs. So long as the professors of that religion, whose doctrine and morals are contained in the Bible, apply themselves, as they have hitherto done, to explain its contents, the learning of Christians will be eminently conspicuous. Nay, a well-grounded system of biblical interpretation presupposes no slight degree of knowledge, and compels the instructors of the rising clergy to apply themselves closely to literary pursuits, in order to acquire a knowledge of the ancient oriental languages; of the most celebrated works of the Greeks and Romans; of ancient history; and of many sciences for which the constant exercise of the power of thinking is required. It cannot be denied that the interpreters of Holy Scripture, both Jews and Christians, have often swerved from the truth, and introduced error, superstition, and prejudice, instead of a sound knowledge of religion and ethics. But it was precisely the want of a well-regulated and systematic scheme of interpretation, which produced such disorders of a fanatical imagination, or, to say the least, such palpable aberrations of the understanding. As, even with the possession of much knowledge, both philological and philosophical, numerous and long-continued errors have been mixed up with the important work of biblical interpretation, it is evident that a system of interpretation, founded on sound principles of reason—on philology, grammar, and history, is in the highest degree necessary for future teachers of religion." (Seiler's 'Biblical Hermeneutics.')

The Bible is divided into the Old and the New Testament. At present we confine our observations to the Old, which is written in Hebrew, with the exception of some chapters in Daniel and Ezra, and a verse in Jeremiah written in Chaldee.

The name *Old Testament* was introduced by the apostle Paul, who wrote concerning the Jews: "Their minds were blinded: for until this day remaineth the same vail [put over the face of Moses] untaken away in the reading of the *Old Testament*," 2 Cor. iii. 14.

The Greek expression *παλαία διαθήκη* (*Palaia Diathéke*) means *old covenant* or old testament, and was translated in the Latin Vulgate, *Vetus Testamentum*. This name became usual among those European nations who recognised the supremacy of the Roman See and the authority of the Vulgate; but Sclavonic nations, for instance the Russians and Poles, divide the Bible into the Old and the New Law. Tertullianus ('adv. Marcionem,' iv. 1.) and Augustinus ('de Civitate Dei,' xx. 4. epist. Pelag. iii.) call the Old Testament *Vetus Instrumentum*.

The following ancient appellations given to the Old Testament are more or less expressive of the veneration in which it was held:

הַכָּתוּב כְּתָבָא בְּתָב, *ἡ γραφὴ* (2 Pet. i. 20), *αἱ γραφαὶ* (Matt. xxii. 29; Acts xviii. 24.)

כְּתְבֵי הַקֹּדֶשׁ, *γραφαὶ ἁγίαι* (Rom. i. 2); *ἱερὰ γράμματα* (2 Tim. iii. 15.)

סְפָרִים, סִפְרֵי הַקֹּדֶשׁ *τὰ βιβλία*, תּוֹרָה, *ὁ νόμος* (John xii. 34).

ὁ νόμος, οἱ προφῆται καὶ οἱ ψαλμοὶ (Luc. xxiv. 44).

ὁ νόμος καὶ οἱ προφῆται (Acts xxviii. 23, &c.), *ὁ νόμος, οἱ προφῆται καὶ τὰ ἄλλα βιβλία*, Tes. Sir. Prol.

סֵפֶר הָאַרְבָּעָה וְעֶשְׂרִים הַמִּקְרָא (comp. Neh. viii. 8, where this word occurs, but in a different sense), בֵּית הַמִּקְדָּשׁ, מִקְדַּשְׁיָה, *βιβλία τῆς παλαίας διαθήκης*, vetus Testamentum, sive Instrumentum (compare *ἡ παλαία διαθήκη*, 2 Cor. iii. 14, *βίβλος τῆς διαθήκης*, 1 Mac. i. 57; 2 Kings xxiii. 2, according to the Septuagint).

The names of the New Testament are, *τὸ εὐαγγέλιον καὶ ὁ ἀπόστολος*, or *τὸ εὐαγγελικὸν καὶ τὸ ἀποστολικὸν*, or *ἡ καινὴ διαθήκη*, Novum Testamentum, sive Instrumentum.

With the collection of the Old Testament arose its division into

1. תּוֹרָה, *νόμος*, lex, law, i. e., the five books of Moses.

2. נְבִיאִים, *προφῆται*, prophetæ, prophets.

These נְבִיאִים, or prophets, are subdivided into נְבִיאִים רִאשׁוֹנִים, "the former prophets" (containing the books of Joshua, Judges, Samuel, and Kings), and into נְבִיאִים אַחֲרוֹנִים, "the later prophets." The later prophets (which we alone call prophets, Isa. Jer. Ezech. &c.) are again divided into גְּדוֹלִים, "the great;" and קְטַנִּים, "the small," עָשָׂר תְּרֵי, *βίβλος τῶν δώδεκα προφητῶν, τὸ δωδεκαπρόφητον, i. e.*, the twelve minor prophets.

3. כְּתוּבִים, *γραφεῖα ἁγιόγραφα*, holy writings, containing the Psalms, Proverbs, Job, Song of Songs, Ruth, Lamentations, Ecclesiastes, Esther, Daniel, Ezra, Nehemiah, two books of Chronicles.

The Jews being fond of making new names of the initials of other appellations, call the three first books of their כְּתוּבִים, "holy writings," by the name of "the books," אמ״ת from אִיּוֹב Job, מִשְׁלֵי Proverbs, and תְּהִלִּים Psalms; the word אֱמֶת means *truth*. The books אמת are also called poetical books, and differ in their accentuation from the rest of the Hebrew Old Testament. Solomon's Song, or Song of Songs, Ecclesiastes, Ruth, Lamentations, and Esther, from the חָמֵשׁ מְגִלּוֹת, i. e., *the five rolls*, so called because they are read on certain festivals in their synagogues from manuscript rolls, and are even printed in the shape of rolls. Christians reckon the Song of Songs and the Ecclesiastes among the poetical books, and they gave to Daniel the fourth place among the great prophets, who are called *great* because their remains are more voluminous than those of the so called *minor* prophets, although the latter are not inferior in matter and style.

From the initials of תּוֹרָה, נְבִיאִים and כְּתוּבִים the Jews make another name for the whole Bible תנ״ך *T'nach*, perhaps in allusion to the root תָּנַן, he *ceased*, or was *finished*.

If we count both books of Samuel, Kings, and Chronicles, we find that the Old Testament consists of thirty-nine books; but the Talmud counts only twenty-four books, because the twelve minor prophets are considered as one book, and the books of Samuel, Kings, Chronicles, Ezra, and Nehemiah constitute, according to the Talmudists, only four books. (Baba Bathra, f. 14, c. 2.) After the five books of Moses, the rest of the biblical books are enumerated as follows:—

סדרן של נביאים יהושע ושופטים שמואל ומלכים ירמיה ויחזקאל
ישעיה ותרי עשר : סדרן של כתובים

רות תהלים ואיוב ומשלי וקהלת שיר השירים וקינות דניאל ומגילות אסתר
עזרא ודברי הימים

The arrangement of the Septuagint and Vulgate, which is followed in the English Bible, will be explained under SEPTUAGINT, and VULGATE.

Josephus, who was born A.D. 37, in a passage which we shall soon quote from Whiston's translation, enumerates twenty-two biblical books (*δύο μόνα πρὸς τοῖς εἴκοσι βιβλία*), which he probably numbered as follows:—

Five books of Moses.	1. Genesis. 2. Exodus. 3. Leviticus. 4. Numbers. 5. Deuteronomy.
The Prophets in thirteen books.	6. Joshua. 7. Judges and Ruth. 8. Two Books of Samuel. 9. „ „ Kings. 10. „ „ Chronicles. 11. Ezra and Nehemiah. 12. Esther. 13. Isaiah. 14. Jeremiah and Lamentations. 15. Ezekiel. 16. Daniel. 17. Twelve minor prophets.
The other four contain hymns to God and maxims for the conduct of life.	18. Job. 19. Psalms. 20. Proverbs. 21. Ecclesiastes. 22. Song of Songs.

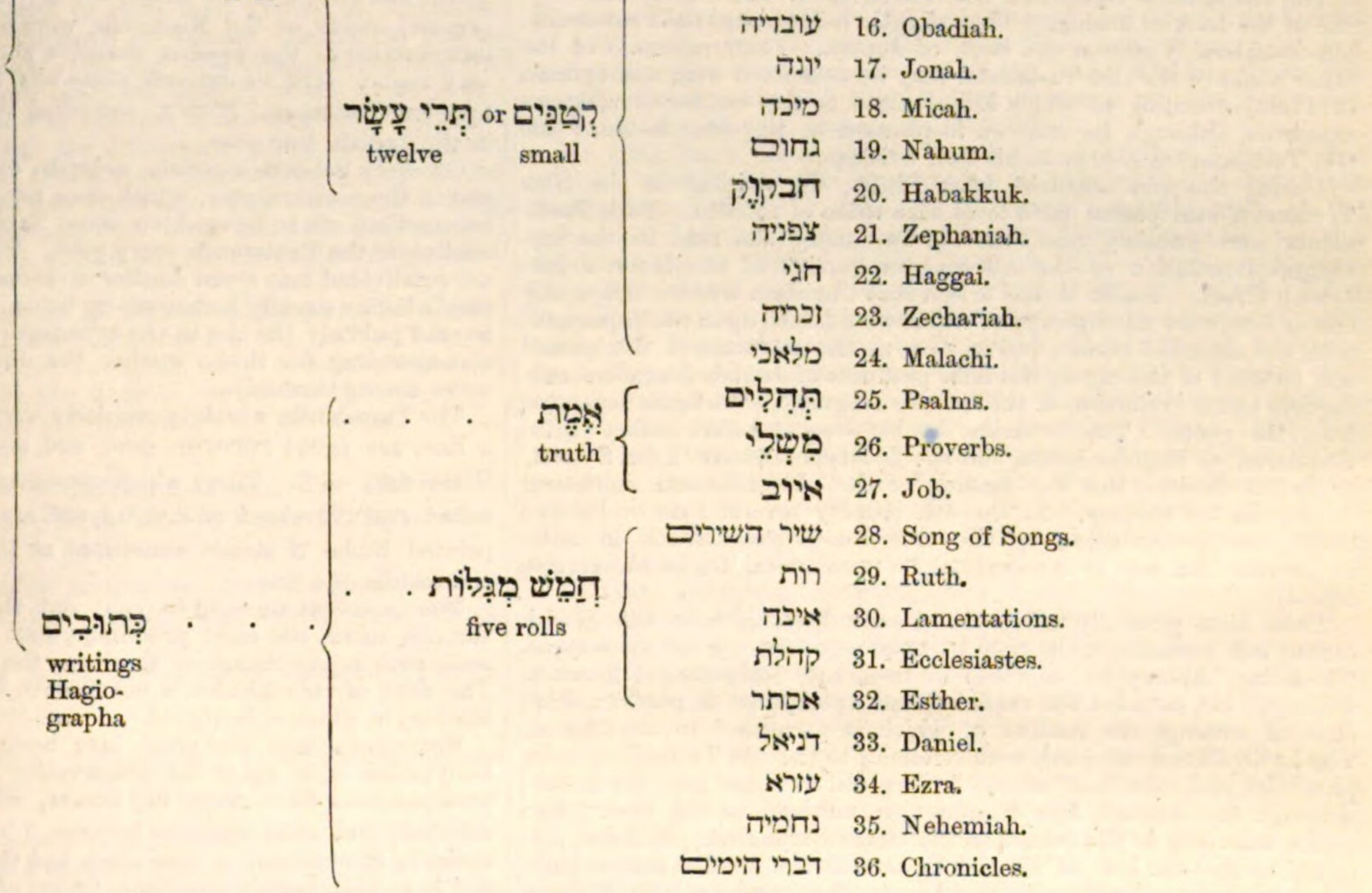
This rather artificial arrangement arose from a desire of having as many and no more biblical books than there are letters in the Hebrew alphabet.

In the Ecclesiastical History of Eusebius (iv. 26), Meliton, in a letter to Onesimus, states that he travelled to the East in order to investigate exactly the nature of the Old Testament in those countries in which it was written, and where the events related therein happened; and that he found the following to be the names of the books contained in the Old Testament: *Μωϋσέως πέντε· Γένεσις, Ἔξοδος, Λευιτικὸν, Ἀριθμοι, Δευτερονόμιον· Ἰησοῦς Ναυῆ, Κριταὶ, Ροὺθ, Βασιλειῶν Τέσσαρες* (that is, 2 Sam. and 2 Kings), *Παραλειπομένων δύο, Φαλμῶν Δαβὶδ, Σολομῶνος Παροιμίαι, ἡ καὶ Σοφία, Ἐκκλησιαστὴς, Ἆσμα ᾀσμάτων, Ἰώβ· Προφητῶν, Ἡσαίου, Ἱερμίου· τῶν δώδεκα ἐν μονοβίβλῳ, Δανιὴλ, Ἰεζεκιὴλ, Ἔσδρας.* Here we have Nehemiah and Esther omitted, but again the number twenty-two.

In the Ecclesiastical History of Eusebius (vi. 25), a passage from Origen is quoted, which states that, according to the tradition of the Hebrews, there are twenty-two canonical books, which is the number

of their letters. Origen seems to have forgotten the book of the twelve minor prophets; and so it happens that, having promised to count twenty-two books, he enumerates only twenty-one. In the Latin version of Eusebius by Ruffinus, the book of the minor prophets is inserted after the Canticles; and in a similar manner Hilarius expresses himself in the prologue to the Psalms, which he translated from Origen.

After these observations the following diagram will be understood, and will facilitate the finding of Hebrew passages, since most Christians are accustomed to a different succession of biblical books :—



According to a Jewish tradition, Moses was the first who wrote. In the subsequent heroic times of the Hebrews we find the noting down of historical facts and the composition of poems; but Hebrew literature received its chief impulse at a later epoch from Samuel's "Schools of the Prophets," which produced the best specimens of moral or didactic and lyric poetry, and the finest prophetical compositions.

That several documents and books of ancient Hebrew literature have been lost, is in itself very credible, and it appears, from the difference of style, that Genesis is formed out of various documents. [GENESIS.] The book of Jasher is twice quoted (Jos. x. 13; 2 Sam. i. 18), but the compilations in Hebrew and in English extant under this title are forgeries. [JASHER.] The books of Chronicles and Kings are extracts from larger records, to which the reader is frequently referred by such phrases, "Now the acts of David the king, first and last, behold, they are written in the book of Samuel the seer, and in the book of Nathan the prophet, and in the book of Gad the seer," 1 Chron. xxix. 29. "And the rest of the acts of Solomon, and all that he did, and his wisdom, are they not written in the book of the acts of Solomon?" 1 Kings xi. 41. 'Now the rest of the acts of Solomon, first and last, are they not written in the book of Nathan the prophet, and in the prophecy of Ahijah the Shilonite, and in the visions of Iddo the seer against Jeroboam the son of Nebat?" 2 Chron. ix. 29. Solomon "spake three thousand proverbs, and his songs were a thousand and five," most of which are not extant now. Even by counting the subdivisions in the Solomonic writings now extant, the above numbers cannot be produced. According to the rabbinical mode of counting stated in Hebrew at the conclusion of biblical books, the number of verses in the book of Proverbs is 915, in the Song of Songs 117, in Ecclesiastes 222.

With the restoration of the ancient constitution and manners there was excited a literary zeal for collecting those remains of national literature which were neglected during the Babylonian captivity. To this zeal for collecting the ancient holy writings the Old Testament owes its formation. But the zeal for national literature survived the national language, and accordingly the body of the Apocrypha was added, after the Old Testament had been brought to a conclusion, about B.C. 150. Ezra, and the other members of the great synagogue, have been frequently considered as the founders of the Canon; but the Talmudic passages upon which this opinion rests are by no means decisive; and we have therefore more reason to ascribe this merit to Nehemiah, concerning whom we read in the 2 Maccabees, ch. ii. ver. 13, "the same things also were reported in the writings and commentaries of Neemias, and how he founded a library, gathered together the acts of the kings and the prophets, and of David, and the epistles of the kings concerning the holy gifts. In like manner Judas also gathered together all those things that were lost by reason of the war we had; and they remain with us."

The most ancient record of the Old Testament as a collection is in the prologue of Jesus son of Sirach, about B.C. 130 under the appellation

of *νόμος καὶ προφῆται*, "the law and the prophets." "Whereas many and great things have been delivered to us by the law and the prophets, and by others that have followed their steps, for which things Israel ought to be commended for learning and wisdom, and whereof the readers must not only become skilful themselves, but they also that desire to learn be able to profit them which are without both by speaking and writing; my grandfather, Jesus, when he had given himself much to the law and the prophets, and the other books of our fathers, and had gotten therein good judgment, was drawn out also himself to write something pertaining to learning and wisdom, to the intent that those who are desirous to learn and are addicted to these things, might profit much more by living according to the law." With this we may compare Luke, ch. xxiv. ver. 44; "All things must be fulfilled which were written in the law of Moses, and in the prophets, and in the Psalms concerning me." The Psalms seem here to be the representatives of the Hagiographa or holy writings, which constituted the third part of the Old Testament and followed the law and the prophets.

From the above passages we infer that the Old Testament existed as a collection in the two centuries preceding Christ.

Philo, who flourished about B.C. 41, seems likewise to appeal to the Old Testament as to a collection of books. (See Hornemann, 'Observationes ad Illustrat. Doctrina de Canone Vet. Test. ex Philone,' 1775.) But the clearest proof for the existence of our present canon of the Old Testament is to be found in the first book of Josephus 'against Apion,' c. 8; and compare 'Antiq. Jud.' lib. xi. cap. 6, s. 19.

When the Hebrew language died away, the canon of the Old Testament became closed.

The Samaritans recognised the authority of the Pentateuch only, and of the book of Joshua. They slightly interpolated the Pentateuch, but considerably altered the book of Joshua. Their rejection of the other books of the Old Testament may be compared with the opinion of Philo, according to which Moses alone is the teacher of religious mysteries, although he ascribes inspiration to the other books of the Old Testament as well as to his own writings.

During the first centuries after Christ, the writings of the New Testament were placed on a level with those of the Old. Both Testaments were publicly read; the Old Testament was read in the Septuagint translation or the Alexandrine version of the Hebrew into Jewish Greek. Hence it has arisen that Christian writers frequently cite as Scripture the Apocrypha which were mixed up in the Septuagint with the canonical books; but as soon as the attention of the learned was directed to the canon, the later products of Jewish literature subsequent to the extinction of the Hebrew language, were again separated from the canon. The canonical books were therefore called 'Libri Regulares,' or Regular Books, and the Apocryphal books 'Libri Secreti,' or Secret Books. But the reading of the 'Libri Secreti' continued during the 3rd century. In the 4th century several lists of Biblical books were promulgated by the orthodox Greek Church in order to prevent the use of Apocryphal or uncanonical books (*ἀκανόνιστα βιβλία*).

These lists generally adhere, in the Old Testament, to the Jewish canon; but fluctuate in the New Testament concerning the Apocalypse. The name 'Apocrypha' signifies in these lists fictitious and heretical writings; but between the canonical and Apocryphal is placed a third class of writings, the reading of which is permitted to the Church. The Latin Church adopted, with reference to the Old Testament, laxer principles, and admitted several Apocryphal writings into the canon; although the learned, like Hieronymus, adhered to the twenty-two books, according to the letters in the Hebrew alphabet. Hilarius also mentions that the law of the Old Testament was divided into twenty-two books, corresponding in number to the letters of the Hebrew alphabet; but adds that, according to the opinion of others, Tobit and Judith should be added in order to complete the number of the Greek alphabet; which contains twenty-four letters. The Protestants, returning to the Jewish canon, separated the Apocryphal additions of the Alexandrine version, which were for the first time decidedly made canonical by the council of Trent in opposition to the Reformers. The council of Trent decrees, in its fourth session, that if anybody will not admit as holy and canonical all the entire books and all their parts extant in the Latin Vulgate, he shall be *anathema*.

After these general remarks concerning the formation of the canon, we shall briefly survey the history of the text.

Before the Babylonian exile the Biblical books were written in the characters still extant in the legends of the Asmonæan coins, of which we have given specimens in the article ALPHABET. Instead of the antique Hebrew character which is nearly allied to the Samaritan, there was employed after the Babylonian captivity a sort of Aramaic alphabet, which was gradually changed by transcribers into the present square character, of which the Spanish, the German, and the intermediate or Italian are three modifications found in Hebrew manuscripts. The characters printed in modern editions of the Hebrew Old Testament are formed according to the Spanish manuscripts, which are the most beautiful. The characters employed in the publications of Sebastianus Münster at Basel about 1530, are imitations of German manuscripts.

The Italian and French Jews wrote in a middle style, between the Spanish and German. The Rashi, Rabbinical, and cursive Hebrew

characters represent the gradual changes of the square characters to a Hebrew running hand, which are also occasionally employed in manuscripts written for private use, and are therefore less accurately revised, and consequently of less authority than those written for public use in synagogues. The most ancient manuscripts had neither vowels nor diacritical marks, nor were the words always divided. (See Hupfeld, 'Beleuchtung dunkler Stellen in der alt-testamentlichen Textgeschichte. In den Studien und Kritiken,' 1830.)

Verses and punctuation, which are already mentioned in the Talmud, are marked in Hebrew by accents, which served also as rhythmical marks to be observed in the Oriental style of reading, which approaches to singing. Hieronymus followed probably the פסוקים, *sections*, mentioned in the Talmud, in dividing the prophetical and poetical books into *cola* et *commata*, and the historical books into *cola* only.

In old Hebrew manuscripts, as well as in those of the Septuagint and Italian version, the poetical books are written in hemistichs or half verses, thus:—

Sepulchrum patens est guttur eorum.
Linguis suis dolose agebant.
Venenum aspidum sub labiis eorum.

The present division into chapters, which the Jews have adopted, is of Christian origin, and does not occur before the 13th century. By some it is ascribed to Stephen Langton, Archbishop of Canterbury, who died in 1227; by others to Cardinal Hugo von St. Caro, who died in the same century. The Psalms was the first portion of the Old Testament numbered in verses, in the edition of Jaques le Febre, printed by H. Stephens in 1539. The *capitula* of Hieronymus, the Tituli and *Breves* in the Latin, the סדרים or סדרין, *orders*, and סמנים (*σημεῖα*) *marks*, of the Masoreths, were so fluctuating that, before the introduction of the present chapters and verses, the quotations were very vague. The Pentateuch alone was in ancient times divided into fifty-four "sections," פרשיות, according to the number of the Sabbaths in the Jewish leap year.

On every Sabbath a certain sederah, or parasha or section, is read, and in the common year, which does not contain fifty-four Sabbaths, two sections are to be read on some Sabbaths, so as to complete the reading of the Pentateuch every year. The Parashioth, or "sections," are subdivided into seven smaller divisions, according to the number of men who are usually honoured by being called upon on the Sabbath to read publicly the law in the synagogue. But in these divisions and in accounting for them, neither the Jews nor the learned perfectly agree among themselves.

The Parashioth, which in regularly written manuscripts commenced a line, are called פתוחות, *open*, and are marked in printed Hebrew Bibles פפפ or פ. Those which commence in the middle of a line are called סתומות *closed* or *shut* up, and are marked ססס or ס. But in printed Bibles ס stands sometimes at the commencement, and פ in the middle of a line.

The *open* sections seem to point out the different topics treated of; the *close* mark, the most prominent and natural divisions of the open ones, such as the change of speakers, the incidents of a narrative, &c. The date of this division is not known, but is certainly older than the Mishna, in which it is quoted.

Notwithstanding the great care bestowed by the Jews after the Babylonian exile upon the preservation of the Hebrew text, some transpositions have crept in; letters, words, and sentences have been omitted; and some mistakes between ר ד. כ ב. יון. נ ג &c., as well as errors in the division of the words and the filling up of abbreviations, &c., have been made; sometimes letters of a similar sound, synonymous words, and those of similar sound and parallel passages were exchanged. Some alterations were also introduced by the officiousness of critics in removing expressions which they either deemed offensive or hard to be understood, or not perfectly analogous to parallel passages. A comparison of the parallel passages in the Old Testament shows that these alterations happened most frequently in the most ancient times before the ecclesiastical authority of the canon was established. Comp. Ps. xiv. with liii.; xl. 14th seq. with lxx.; xviii. with 2 Sam. xxii.; Ps. cviii. with lvii. 8—12; lx. 7—14; Ps. cv. with 1 Chron. xvi. 8—22; Ps. cxvi. with 1 Chron. xvi. 23—33; Is. xxxvii. xxxviii. with 2 Kings xviii. xix.; Jer. lii. with 2 Kings xxiv. Compare also the parallel passages in the books of Samuel, Kings, and Chronicles; Is. xv. xvi. with Jer. xlviii. and other passages cited in Eichhorn's 'Einleitung,' i. pp. 139, 6; Bauer, 'Critica Sacra,' p. 236, seq.; Gesenius, 'Geschichte der hebräischen Sprache,' p. 38, seq. Although these alterations do not materially affect the tenor and scope of biblical doctrine, it has been the business of critics to collect and to compare the various readings of the Hebrew text, and thus to restore its original purity.

The oldest recension of the Hebrew text, coming from a quite different quarter, and being independent of the usually received text, is that of the Samaritan Pentateuch, which seems to be closely related to the copy from which the Septuagint interpreters translated. The various readings of the Samaritan Pentateuch were for a considerable time overvalued by some and despised by others, and herein both parties frequently showed more zeal than knowledge. But the

examination of the Samaritan text by Gesenius ('De Pentateuchi Samaritani origine, indole et autoritate Commentatio Philolol. crit. scripsit Guil. Gesenius;' Hal. 1815, 4to) has shown that the assertions of the zealots against the Codex Samaritanus, although produced without reason, were not substantially wrong. Its character is uncritical; most of its characteristic readings have arisen from injudicious grammatical corrections, inserted glosses, explanatory conjectures, grammatical and historical additions and alterations according to parallel passages, Samaritanisms in language and doctrine, as for instance the substitution of Garizim, גריזים, for עיבל in Deut. xxvii. 4.

The Jews in Babylon and Palestine appear to have been more critical than those in Egypt and the Samaritans, because Aquila, and the other Greek translators after Christ, and Onkelos and Jonathan agree more with the Masoretical text than the Septuagint. About the time of the birth of Christ arose schools of learning, especially in law, grammar, and criticism. After the destruction of Jerusalem these schools were transplanted to Jabne, Ziphoria, Lydda, Cæsarea Palestina, formerly called Straton's Tower, on the coast of the Mediterranean, Tiberias, and at a later period to Sora, Pumpeditha, and Nahardea on the banks of the Euphrates.

Origen, in composing the Hexapla, perused a Masoretical manuscript in the 3rd century after Christ, and in the 4th century Hieronymus employed Palestine teachers and MSS. The present received text originates from Palestine. Therefore the interpretations and readings of Hieronymus are nearly allied to the present received text. Many passages indicate that Hieronymus employed an unpointed text.

Eight MSS. form the basis of the text of the Old Testament. They are: the Codex Babylonicus, the Codex Palestinus or Egyptus, the Codex Sinai, an Egyptian MS. supposed to have been written at Jerusalem and carried to Egypt, the Pentateuch of Jericho, thought to be the most correct, the Codex Sanbaki, and the book Tagin containing the Pentateuch only. The Hebrew MSS. are superior on the whole to the Samaritan, yet the Samaritan was followed in the Septuagint and our Saviour has quoted from it, and the differences are but slight. It has been a question whence the Samaritans obtained their copy of the Pentateuch. Gesenius thinks that when the tribes were carried away captive to Assyria, some copies may have been left with the remnant, which passed into the hands of the mixed race afterwards called Samaritans.

The Talmud contains precepts of biblical calligraphy (Tr. Gittin, f. 45, c. 2), mentions a comparison of manuscripts (Hieros. Tr. Taanith, f. 68, c. 1, compare Tr. Sopherim, vi. 4), and refers to certain classes of biblical emendations prior to the Talmud, called by Morinus 'fragmenta' or 'vestigia recensionum;' by Eichhorn, 'Revisiones.' These classes are

I. עִטּוּר סוֹפְרִים, ablatio scribarum, concerning the omission of vau ו in Gen. xviii. 5, xxiv. 55; Num. xii. 14; Ps. lxviii. 26, xxxvi. 7. See Nedarim, f. 37, c. 2.

II. תִּקּוּן סוֹפְרִים, correctio scribarum, concerning sixteen or eighteen erroneous passages, for example, Gen. xviii. 22; 1 Sam. iii. 13.

III. Puncta extraordinaria in fifteen words, for example, Ps. xxvii. 13, לוּלֵא. Tr. Sopherim, vi. 3.

IV. קְרִי וְלֹא כְתִיב, if there was anything to be read which was not written, 2 Sam. viii. 3, xvi. 23. Nedarim, f. 37, c. 2.

V. כְּתִיב וְלֹא קְרִי, if there was in reading to be omitted what was written in the text, as in 2 Kings v. 18.

VI. קְרִי וּכְתִיב, various readings, as Job xiii. 5, Hagg. i. 18.

After the conclusion of the Talmud in the 6th century, the Jewish scribes continued, especially in Tiberias, to propagate their critical traditions, at first orally, afterwards by writings; these writings were afterwards placed in the margin of the manuscripts. Subsequently those critical remarks were improved and augmented by the so called בעלי מסורה "the lords of the Masora," who also counted the number of the verses, of the words, and of the consonants in the biblical books.

There exists also in the rabbinical bibles of Bomberg and Buxtorf, and in the sixth volume of the London Polyglott, a list of various readings by Rabbi Aharon Ben Asher, and Rabbi Jacob Ben Naphthali, of the 11th century. The readings of Ben Asher are preferred by the western, and those of Ben Naphthali by the eastern Jews. From the circumstance that their observations regard exclusively the vowels and accents, we conclude that the punctuation of the text was already accomplished in their days, and that they employed punctuated manuscripts.

After the origin of the Masora, the MSS. were probably often altered accordingly. But we have reason to think that no material change took place, because even the complaint of Meir Hallevi about the corruption of the manuscripts refers especially to abbreviations which do not affect the sense. The famous MSS. of the rabbins in the middle ages, as that of Hillel, Ben Asher (called the Egyptian or Hierosolymitan), and that of Ben Naphthali and others, adhered to the Masora. The following are among the more important editions of the various texts:—

The earliest editions of the Hebrew bible were imitations of ancient manuscripts, and have therefore critical authority. The oldest Hebrew prints contain only parts of the Old Testament. The oldest specimen of Hebrew typography contains the Psalms with the Commentary of Kimchi, 1477, probably printed at Bologna. A very old specimen of Hebrew typography was presented by Dr. Pellet, in 1735, to the library of Eton College, containing the Cethubim or Hagiographa, printed at Naples in 1487. This edition was burnt by the Jews, probably on account of its readings frequently differing from the Masora, which was considered already at that period the standard of correctness. The copy at Eton is printed on vellum, and is considered the only one that escaped the flames.

I. The first complete edition of the Hebrew bible was printed at Soncino, in the Cremonese territory in the dukedom of Milan, 1488, small fol. The edition of Brescia, 1494, 4to. which Luther translated, generally follows the text of this Editio Princeps. (See J. G. Palm de Codicibus Veteris et N. T. quibus b. Lutherus in conficienda interpret. Germ. usus est, Hamb., 1753. B. W. D Schulz vollst. Kritik üb. d. gewöhnlichen Ausgaben d. Hebr. Bibel nebst einer Nachricht v. d. Hebr. Bibel welche Luther bei s. Uebersetzung gebraucht, Berlin, 1766, 8vo.) To this first edition of printed bibles belong also, Bibl. Rabbinica, Bombergii ed. Felix Pratensis, 1517, and the smaller editions printed by Bomberg in 1518, and in 1521, 4to: the edition of Robert Stephanus, 1539-1544, 4to: and Bibl. Hebraica stud. Seb. Münsteri, Basileæ, 1534-1536, 4to, two volumes.

II. An independent text, which became the basis of other editions, is contained in the Biblia Polyglotta Complutensia, finished in 1517, but not published till 1522. Alvarez Gomez de Gestis Francisci Ximenii (Compluti. 1569, fol. L. ii. p. 47) says that there were bought for 4000 aurei, seven Hebrew MS. copies from various countries, and that these copies were preserved at Complutum (Alcala). From this second edition proceeded Bibl. Polygl. Bertrami ex offic. Sanctandr. 1586, fol. (also ex offic. Commelin, 1599, 1616).

III. Bibl. Rabb. Bomberg. II. Cur. R. Jac. B. Chajim, Venet. 1525–26, fol. Although Jacob Ben Chajim in this edition followed the Masora more than the MSS., it influenced strongly most of the subsequent editions, and the following belong entirely to this third recension: Biblia Rabb. Bomberg. III., Venet. 1547-1549, fol.; Bibl. Rabb. per Jo. de Gara, Venet. 1568, fol.; Biblia Rabb. Bragadini, Venet., 1617-18, fol.; Bomberg's quarto editions of 1528, 1533, and 1544; the edition by R. Steph., Paris, 1544-46, in 16mo; some alterations were made in the Justinian editions, Venet., 1551, 4to; 1552, 18mo; 1563, 4to; 1573, 4to; B. Hebr. Genev., 1618, in 4to, 8vo and 18mo; B. Hebr., per J. de Gara, Venet., 1566, 4to; 1568, 8vo; 1682, 4to; B. Hebr. typ. Bragadin., Venet. 1614-15, in 4to and 12mo, 1619, 4to, 1628, 4to, 1707; Bibl. Hebr. Chr. Plantin. Antv. 1566, in 4to, 8vo, and 16mo; Biblia Hebraica, Hartmanni Frcf. ad Viadr. 1595, in 4to, 8vo, and 16mo; 1598, 4to; B. Hebr. Zach. Cratonis Viteb. 1586 (1587), 4to.

IV. Bibl. Polyglott., Antwerp, 1569-72, fol., represent a text composed of the two last recensions. This polyglott contains in the first four volumes the Old Testament with the apocrypha interspersed. From this proceeded the Plantine Hebrew and Latin, Ant., 1571, fol.; 1584, fol.; L. B. 1673, 8vo; B. Hebr. Lat. Burg. Aurac. in Hisp., 1581, in fol.; B. Hebr, Lat., Genev., 1618, fol.; Bibl. Hebr. Lat. sumt. Fr. Knoch Frcf. ad Moen., 1618, fol.; Bibl. Hebr. Lat., Vienn., 1743, 8vo; Bibl. Polyglott. Par., 1645, fol.; Bibl. Polyglotta, Lond. ed. Brian Walton, 1657, fol.; B. S. quadrilingua, accur. Christ Reineccio, Lips., 1750, fol., and the manual editions by Reineccius, Lips., 1725, 8vo; 1739, 8vo, and 4to; 1756, 1793, 8vo.

V. Bibl. Hebr. cura et studio Eliæ Hutteri, Hamb., 1587, fol. (1588, 1596, 1603), contains a text compounded of the Venice, Paris, and Antwerp editions. Hutter's text is repeated in Hutter's Polyglotta, Nürnberg, 1591, fol. (this Polyglott was not completed), and in Nisselii B. Hebr. 1662, 8vo.

VI. Buxtorf's octavo edition, Basel, 1611, was the prototype of B. Hebr. typis Menasseh Ben Israel, sumt. Jansonii, Amst. 1639, 8vo. (The editions by Menasseh Ben Israel in 1630–31 and 1631–35 have another text.) Bibl. Rabb. Buxtorf, Bas. 1618–19; Bibl. Rabb. op. Mos. Francfurt, Amst. 1724, fol.

VII. B. Hebr. correcta et collata cum antiquissimis et accuratissimis exemplaribus manuscriptis et hactenus impressis (cum præfat. Johannis Leusden), typis Jos. Athiae, Amst. 1661, 8vo, and 1667, 8vo. From this edition originated the following:—B. Hebr. Clodii Francf. ad Moenum, 1677, 8vo, recogn. a J. H. Majo et ultima resv. a J. Leusdeno, Francf. a M. 1692, 8vo; Biblia ad optimorum tam impressorum Clodii, Jablonskii, Opitii, quam manuscriptorum aliquot codicum fidem collata; direxit opus J. H. Majus, collat. instituit. G. Chr. Bürclin, Frcf. a M. 1716, 4to; B. Hebr. ex rec. Dan. Ern. Jablonskii, Ber. 1699, 8vo, maj. This sometimes deviates from Leusden according to the authority of manuscripts and the cardinal editions, namely, Bombergiana, Venet. Regia, Basileensis Buxtorfii, Hutteriana, Menassis, ed. 2, Berlin, 1772, 12mo. After this B. Hebr. J. H. Michaelis, Hal. M. 1720, 8vo, maj. Cardinal editions are those "quæ reliquarum quasi cardinales videbantur," the authority of which was followed by others. After Athias also B. Hebr. stud. et op. Henr. Opitii Kil. 1709, 4to; and after this

Bibl. Hebr. Züllich, 1741, 4to. B. Hebr. Ever. van der Hooght, Amst. et Ultraject. 1705, 8vo, is a reprint of Athias's edition of 1667. Van der Hooght's reprint is famous for its accuracy. After this B. Hebr. Sal. Ben Jos. Proops or Props, Amst. 1724, 8vo; B. Hebr. Lat. (c. vers. Seb. Schmidtii), Lips. 1740, 4to; B. Hebr. Lat. Car. Frc. Houbigant, Paris, 1753, 4 vols. fol.; B. Hebr. Jo. Simonis Hal. 1752, 8vo, 1767, 8vo; Biblia Hebr. Benj. Kennicot. Oxon. 1776–80, fol. (See Bruns de Mendis typographicis editionis Van der Hooght, a Kennicoto non sublatis in Eichhorn's Rep. xii. 225, seq.) Van der Hooght's Bible has been frequently reprinted in London. Editio nova, recognita et emendata a Josepho Samuele Frey, Typis Societatis ad promovendam Christianitatem inter Judæos, Lond. 1812, 8vo; B. Hebr. ad ed. Hooghthianam adornata, Lond. typis et sumptibus Sam. Bagster, 1823. In stereotype, Recognita et emendata a Judah d'Allemand, Typis A. Macintosh, impensis Jacobi Duncan, 1823, 1825, large 8vo; duodecimo with Hebrew title, 1825; large 8vo, reprinted 1828, 1830, corrected by Hurwitz, 1833. The most beautiful type is employed in the Biblia Hebraica secundum editiones Jos. Athiae, Jo. Leusden, Jo. Simonis aliorumque imprimis Everardi van der Hooght, recensuit Augustus Hahn, Theol. Doctor et Professor in Acad. Lipsiensi, editio stereotypa sumptibus Caroli Tauchnitz, 1831, 8vo, and in 12mo, 1833.

VIII. Vetus et Novum Testamentum, ex antiquissimo Codice Vaticano, edited by Cardinal Angelo Mai, published at Rome in 1858, in 5 vols. fol.

IX. Vetus Testamentum Græce juxta LXX. ed. by Dr. C. Tischendorf, 2 vols. 8vo, Leipz. 1850. This is a collation of the Vatican text with all the recently discovered codices.

X. Biblia Polyglotta. Hebrew, Greek, Latin, and German, ed. by Dr. Stier and Dr. Theile, 6 vols. royal 8vo, Bielef. 1850-55.

The following is a list of the critical apparatuses by which the text has been purified:—The great and the small Masora, and various readings in the rabbinical Bibles of Bomberg and Buxtorf. Selections of various readings in the editions of Münster, Van der Hooght, and in the מנחת שי, with the critical commentary of R. Sal Norzi, Mantua, 1742–44, 4 vols.; C. F. Houbigant Notæ criticæ in univ. V. T. libros cum Hebraice tum Græce scriptos cum integris ejusdem Prolegomenis ad Exemplar Parisiense denuo recusæ, tom. i. ii. Francf. a M. 1777, 4to. Comp. J. D. Michaelis Vorrede, zum kritischen Collegio über die drei wichtigsten Psalmen von Christo; J. Chr. Kallii Prodr. examinis criseos Houbigantianae in Cod. Hebr. Hafniæ, 1763, 4to; Ej. Examen cris. Houbig. in Cod. Hebr. spec. i. Hafn. 1764, 4to; Seb. Rau Exercitationes phil. ad Houbigant. Prolegomena, 1785, 4to; Kennicott's Dissertations on the Hebrew text and his Bible. Com. Bruns de variis lectionibus Bibl. Kennicot. in Eichhorn's Repertorium xii. 242, seq. xiii. 31, seq.; Bruns Apologie für Kennicot in Eichhorn's Rep. vi. 173, seq.; Rosenmüller's Handbuch, i. 241, seq.; Bibl. Reineccii ed. J. Chr. Doderlein et J. H. Meisner, Lips. 1793, 8vo; B. Hebr. dig. et grav. lectionum varietatem adjecit J. Jahn, Viennæ, 1807, 3 volumes, 8vo. Biblia Hebraica without points, after the text of Kennicott, with the chief various readings selected from his collation of Hebrew manuscripts, from that of De Rossi, and from the ancient versions, accompanied with English notes, critical, philological, and explanatory, selected from English and foreign critics by B. Boothroyd, in two volumes, 4to, Pontefract, without the date.

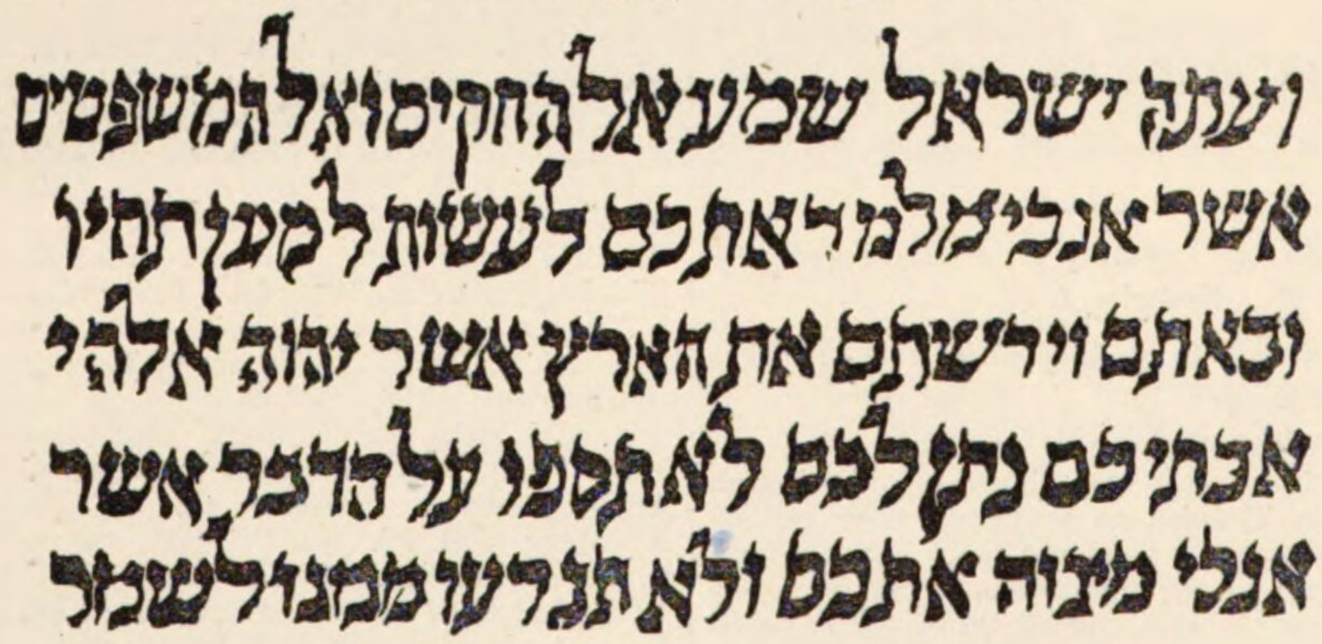
Besides those in the editions of Kennicott, Jahn, &c., we notice the following collections of various readings: מסורה סיוג לתורה ספר, by Rabbi Meir Hallevi, Berlin, 1761; אור תורה printed in שתי ידות, Ven. 1618, and inaccurately, Amst. 1558. Commentatio critica sistens duorum codicum manuscriptorum Biblia Hebr. continentium quis Regiomonti Borussorum asservantur cum præcipuarum variantium lectionum sylloge, auctore D. Theod. Christ. Lilienthal. Regiomonti et Lipsiæ, 1770, 8vo. The most important work of this kind is by J. B. De Rossi; Variæ Lectiones Vet. Test. ex immensa Manuscriptorum editorumque codicum congerie haustæ et ad Samaritanum textum, vetustissimas versiones, et accuratiores sacræ criticæ fontes ac leges examinatæ, Parmæ, 1784-88; iv. volumina 4to. maj.; and Scholia crit. in V. T. libros, seu supplementa ad varias sacri textus lectiones, Parmæ, 1798.

Besides the Polyglotts mentioned above, there was the Paris Polyglott of 1645; and the London Polyglott, edited by Brian Walton; and Mr. Bagster's of 1831, which contains in one folio volume the Hebrew text, the Samaritan Pentateuch, the Septuagint, the Vulgate, and the Syriac versions, for the Old Testament; and for the New, the Greek text of Mill, with Luther's German translation of the Bible, Ostervald's French, Diodati's Italian, Scio's Spanish, and that of the English authorised version. Since the first publication of these, there have been several editions, and some varieties of form.

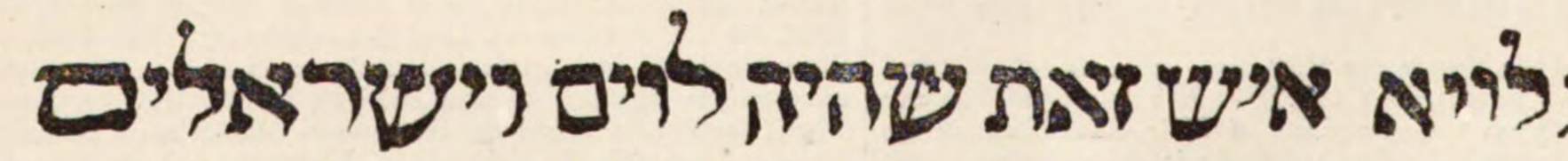
Among the oldest manuscripts, nearly 1500 in number, which have been collated, is the Laudianus in the Bodleian Library at Oxford, which is considered to be 800 years old: this MS. differs in 14,000 readings from Van der Hooght's text, which is now in common use. Besides this there are many important MSS. at Oxford and in the British Museum in London, one in the library of the Royal Society, one in the Lambeth Library, and one MS. of the Pentateuch in the library of the London University. In the seventh and the following volumes of the 'Classical Journal' is a catalogue of MSS. existing in the public libraries of Great Britain, and a very complete list of Hebrew MSS. is prefixed to De Rossi's 'Variæ Lectiones:' less complete in Kennicott's 'Disertatio Præliminaris.'

These codices are known among critics by names like the following: Carlsruhensis, Viennensis, Cesenæ, in the Malatesta Library at Bologna, Florentinus 2, Mediolanensis 9, Norimbergensis 4, Parisiensis 27, Regiomontanus 2, Parisiensis 24.

A fac-simile of Deut. iv. 1, 2, from an ancient Hebrew MS. of the Pentateuch, called by the Rev. H. Horne Codex Malabaricus, may serve to illustrate the appearance of these codices; it was brought in the year 1806 from the interior of Malayala by the late Rev. Claudius Buchanan, D.D., and is now preserved in the public library of the University of Cambridge.



It measures forty-eight feet in length. The whole book of Leviticus and the greater part of Deuteronomy are wanting. The original length was about ninety feet. Its breadth is about twenty-two inches, or a Jewish cubit. It seems to comprise the fragments of three different rolls. See a 'Collation of an Indian copy of the Pentateuch,' also a collation and description of a manuscript roll of the book of Esther from the Hebrew extant in brazen tablets at Goa, with an English translation, by Thomas Yeates, Cambridge, 1812, 4to. None of the Hebrew manuscripts is above 800 years old. The reason why the manuscripts of the Old Testament are never found of so high antiquity as the oldest of the New Testament, is that the Jews never suffer their holy manuscripts to exist in a dilapidated state. The manuscripts which begin to be illegible, or contain readings not authorised by the Masora, or are inaccurate, are collected in the גְּנִיזָה, that is, place of deposit, or rather hiding-place, in the synagogue. When this place is filled up, all its contents are removed to be buried in a place of the burying-ground chosen for that purpose. The following line may represent a codex about to be buried for being faulty and illegible.



The unwearied application of the learned in the collation of Hebrew manuscripts has proved that all of them represent nearly the same text that was in the hands of the old translators, which has not suffered any very material alteration in spite of thousands of small changes. This is also proved by the fact that the peculiarities of style which characterise the different biblical writers, have not been effaced. The

old school of the Buxtorfs and their followers believed in the general correctness of the Masoretical text. The correctness of this opinion, however, has been established, not by the opposition of the old school to critical examination, but by the exertions of those critics who for some time overrated the authority of the Samaritan Pentateuch and that of the ancient translations, and overstated the faults of the Masoretical text.

Critics now distinguish, 1st, the text before the conclusion of the canon in the parallel passages of the Old Testament; 2nd, the text before the Masora in the quotations of the Talmud; 3rd, the Samaritan and Alexandrine; 4th, the Masoretical.

The first Samaritan MSS. were brought into Europe in the year of our Lord 1620. Achill. Harlay de Sancy directed Pietro della Valle in 1616 to purchase them at Damascus, and presented them to the library of the Oratorium at Paris. There are extant, besides these, a Codex Cottonianus, a Codex S. Genov. at Paris. Compare also the Barberini Triglotta and the Paris and London Polyglotts in Samaritan types, and the Pent. Hebræo-Samarit. ed. Benj. Blayney, Oxon. 1790, in the usual square characters. [SAMARITANS.]

The earliest translations of the Old Testament were made from a text which belongs to a period from which no manuscripts have been preserved. These translations confirm the significations which are given in our Lexicons to Hebrew words, and show how the biblical text was understood at a period when the original language was still living, or when, at least, many helps to its understanding, which have since disappeared, were still accessible. We shall treat in separate articles on the following most important ancient translations:—

The Septuagint is written in the Hellenistic or Jewish Greek language, and was formerly read in many synagogues. Josephus makes more use of the Septuagint than of the Hebrew text; but at a later period, when Christians employed the Septuagint, the Jews rejected it. The Talmud appoints a fast-day on the eighth day of Tebeth, because "on that day the law was written in Greek through King Ptolemy, and darkness came over the earth for three days; and that day was fatal to Israel as the day on which the calf was made." ('Megillath Taanith,' fol. 50, c. 2 ed. Bas. 1758; 'Tract. Sopher.' ci.)

The fragments which have been preserved of the translation made by the Jewish proselyte, Aquila of Sinope, at the commencement of the second century, are very valuable, because they are so literal that they exactly represent the text which was before the eye of the translator. [AQUILA.] Theodotion only remodelled the Septuagint. His translation of Daniel was used among the Christians instead of the Septuagint. Symmachus wrote better Greek, but translated more freely. Each of these three translated with more accuracy than the translators of the Septuagint.

There are, besides, fragments of three anonymous Greek translations, which have been called, from the places which they occupy in the 'Hexapla' of Origen, Quinta, Sexta, Septima.

Parts of the Old Testament have been translated into a Jewish modern Greek, of which 'Wolfii Bibliotheca Hebræa,' vol. iii. Appendix, and vol. iv. p. 1219–26, contains curious specimens printed in Hebrew type.

According to Origen, Lucianus and Hesychius bestowed their critical labours upon the text of the Septuagint; and their editions came into public use, but have entirely disappeared. It appears from Georg. Syncell. Chronogr. p. 203, that the labours of Basilius the Great on the Septuagint consisted in his care to obtain correct copies.

In the days of St. Augustine, several Latin translations existed: among these he preferred the Itala, which was in more general use, and which had originated in the first period of Christianity. The fragments of the Itala still extant prove that it was made from the Septuagint. Hieronymus corrected it about the year A.D. 382; but the greater part of his labours was lost during his own lifetime, and he could not gratify the desire of Augustine to restore the loss, because he had not sufficient scribes at his command.

According to Abulfaragius, the Syrians had, along with the Peschito, another translation of the Septuagint, which has been called, according to an erroneous reading of Pococke, the Figurata.

Of the Syrian translation by Philoxenus, bishop of Hierapolis, we know so little that we cannot say whether it was the same with the Figurata.

In the Ambrosian library at Milan there are the Psalms, Job, Proverbs, Ecclesiastes, Song of Songs, the Wisdom of Solomon, Sirach, the twelve minor prophets, Jeremiah, Baruch, Lamentations, Daniel, Ezekiel, and Isaiah, in an Hexaplar Syriac translation by Paul, bishop of Tella, of the year 616. Of the same translation there is a copy at Paris of the fourth, or, as we call it, the second book of Kings. This version was translated into Arabic by Hareth Ben Senan, A.D. 1486, and is preserved in the Arabic at Paris and at Oxford.

The Ethiopians have, in the Geez, an anonymous translation of the whole Bible, the origin of which cannot be earlier than the 4th century. This version was made by Christians from the Alexandrine Greek translation, but it is now used by Jews also. Of this there are several complete manuscript copies in Europe, a list of which is given by Ludolf: parts of it have been printed. Other copies have been brought to Europe by Bruce and Rüppell.

There exists also a translation in the dialect of Lower Egypt, the so-called Coptic or Memphitic; and another in the dialect of Upper Egypt, the Sahidic, or Thebaic. The origin of these translations, parts of which have been printed, belongs probably to the end of the 3rd, or the commencement of the 4th century. Both were made from the Septuagint.

The Armenian translation by Miesrob was executed with the assistance of Johannes Ekelensis and Jos. Palnensis, about A.D. 410. With this translation, Miesrob gave to the Armenians an alphabet. He followed the Septuagint, and in Daniel the Greek of Theodotion. Miesrob's translation is said to have been interpolated in the 6th century according to the Peschito, and in the 13th century according to the Vulgate.

The Georgian or Grusingian translation was made in the 6th century, and follows the Septuagint.

The Sclavonic translation is said to have been made in the 9th century, from the text of the Septuagint; but, according to Alter, it originated from the Itala, and was altered in the 14th century according to Greek MSS.

It is unnecessary, in an article so limited as the present, to do more than name the Arabic translations, the Veneta, the Targumim, the Samaritan translation, the Peschito, the Vulgate, the Gothic, the Anglo-Saxon, and Persian translations, &c.

The Hebrews had, like other nations, their prose and poetical styles. The poetical style is distinguished by great boldness and freshness of expression, and by a rhythmical movement or cadence of language. This rhythmus occurs in various degrees. There are parts in the prophets, and in the book of Ecclesiastes, which are scarcely elevated above the level of prose. The gradual ascent from prose to rhythmus, and the descent from rhythmus to prose, constitutes one of the beautiful characteristics of Hebrew poetry. The rhythmus of syllables is, in Hebrew, so free, that some have preferred to call it "numerus by accentuation." This numerus consists usually in a free mixture of iambics, trochees, amphibrachs, and anapæsts.

"The books and passages of the Old Testament, which are composed in a poetical style, have such a diversity of character, from the various times at which they were written, that it is necessary to distinguish them into several periods. Four of these periodical divisions may be conveniently adopted.

"The first embraces short historical songs, and oracular sentences: simplicity and obscure brevity are the characteristics of these. The second era is that of heroic song. In the times of the Judges, the actions of the protectors and defenders of Israel were celebrated in this style. Of the same description are inspiriting war-songs, and songs of triumph. The third period commences with the schools of the prophets, founded by Samuel, in which the art of poetry was enlarged, refined, and ennobled. Historical poems, pastorals, and hymns in praise of God, and war-songs, were produced by these schools. At length, under David and Solomon's reign, we approach the golden age of Hebrew poetry, to which succeeded the sublime oracles of the prophets. They uttered, in solemn strains, promises and threatenings, and described better times to come, in imagery borrowed from the golden age. The fourth epoch coincides with the time about and subsequent to the Babylonian captivity. Then the fiery energy of the prophetic poetry was lost, and plaintive songs of woe were blended alternately with joyful strains, sung in hope of their return to Zion, and with cheerful festive hymns, in which the expectation of a universal kingdom of God on earth was expressed in various ways.

"With respect to the external form, the various species of Hebrew poetry may, upon the whole, be described by the names given to their poetic compositions by the Greeks and Romans; but it must not be imagined that their arrangement and disposition are of the same kind. The following may be considered as distinct species of Hebrew poetry:—

"First, short traditional poems, containing anecdotes of families, for the purpose of handing them down to posterity. Second, longer historico-religious poems; as, for example, 1 Moses (Gen.) i. and ii., also Psalms cxxxv. cxxxvi.; and poems of a mythic form, 1 Moses (Gen.) iii. xi. Third, odes: these are subdivided into—1, Hymns, songs of praise and thanksgiving, for divine worship; 2, Common odes, in which other important objects were expressed in sublime imagery; and, finally, 3, War-songs, which often ascend to the dignity of the ode. Fourth, elegies, lamentations, pastoral lays, and songs in praise of love Fifth, songs of a middle species, which do not attain the character of the ode. Sixth, didactic poems, of which there are—1, Many short ones in the Psalms; and, 2, Some of greater length in Job and Ecclesiastes. To these latter belong—3, Parables, fables, and allegories; and, finally—4, Single sententious apophthegms, or proverbs.

"Descriptions of the separate prophetical books are given in the Introductions (such as those of Eichhorn, Jahn, Berthold, and De Wette) to the Old Testament: but those books must be divided into two classes, in order to facilitate their interpretation, namely, those written before, and those written after the captivity, as the character and contents of the latter differ materially from those of the former writings.

"The first period of those writings is that between Moses and the captivity. The prophets who lived in this period laboured to oppose idolatry; and continually exercised this grand theme of their discourses and denunciations in new forms, and under various images and conceptions. They announced on these occasions the approach of

divine justice in the devastation of the land, and the carrying off of its inhabitants, but they at the same time opened a view into a distant state of future felicity, the return of the better part of the Israelites to the true God, the return of many of themselves out of all tribes to Judæa, and their re-union as a people. They already saw many heathens, proceeding with the Jews towards Jerusalem, for the observance of the same worship; they saw a divine kingdom, whose borders were to be continually enlarging.

"The other period is that from the exile to Malachi. The prophets who lived during this time sustained the hopes of Israel; but they at the same time directed their exhortations to the promotion of the true worship of God, and denounced punishment against hypocritical offerings, against indolence in doing good, against unrighteousness, and many other sins, as being the cause of preventing God from fulfilling, in their complete extent, his promises to the citizens of the newly-restored Jerusalem. Some of the prophets already foresaw a time of severe judicial punishments to be inflicted by God on the refractory Israelites." (Seiler's 'Hermeneutics.')

The English Bible.—No complete translation appears to have been made in the Saxon times into the language then spoken in England. By some writers Bede is said to have made such a translation, but this is now generally understood to be a mistake. That he translated portions of the Scriptures is, however certain. One of the best authenticated facts in his life is, that he was employed in translating the Gospel of St. John into Saxon at the time of his decease. The early writers who relate this fact differ respecting the extent to which he had proceeded in translating this Gospel. No evidence can be produced that the whole of the Scriptures was, by any person, rendered into Saxon. But of the more important portions Saxon versions still exist in manuscript. We shall notice three of the most remarkable copies:—1. A manuscript of the Psalms in Latin, with an interlinear Saxon version. This is now in the Cottonian Library at the British Museum, where it is numerated Vespasian A. i. 2. A manuscript of the Gospels in the same library, numerated Nero D. iv. This contains the Latin text, with an interlinear Saxon version. Both these manuscripts are of singular beauty, and impress the mind with a strong feeling of respect for the monks of Lindisfarn, in whose house, and probably not later than the 8th century, they were executed. 3. Another manuscript of the same class is at Oxford, where it is known by the name of the Rushworth Gloss, on account of its having belonged to Rushworth the historical writer. This manuscript contains the Gospels only. Other manuscripts exist of Saxon versions of portions of the Scriptures in many libraries; and there are notices in writers on Saxon affairs of several persons who, beside Bede, were employed in the translation of these important writings into the vernacular tongue. At the Reformation, when the work of translating the Scriptures met with opposition from the church, it was a point of some importance to draw the public attention to the fact that versions into the vernacular tongue were no novelties in England. It was with this view that Parker, archbishop of Canterbury, encouraged Fox, the writer of the Martyrology, to prepare an edition of the Gospels in Saxon, which he did, and published it in 1571. Another edition, the result of the collation of a greater number of manuscripts, was published in 1638, and again in 1665. This was the joint work of Junius and Marshall. They gave at the same time the text of Ulphilas's version, into the language called the Mæso-Gothic, a kindred, perhaps the parent, language of the Saxon.

Devout persons seem to have employed themselves in rendering portions of the Scriptures into the language spoken in this country, when what we call Saxon was becoming what we now call English. It is thought that the whole of the Scriptures had been translated in the 13th century. It is, however, certain that in the 14th century, not single and separate portions only were translated, but the whole of the books comprehended in the Sacred Canon, and that they were put together in order as they were found in the Latin originals so as to form a volume answering to what we mean when we speak of the Bible. There are two persons, both of the age of King Edward III., who are said to have executed this work. The one, John de Trevisa, a native of Cornwall, was educated at Oxford. He translated the work of Bartholomeus, 'De Proprietatibus Rerum,' and the 'Polychronicon' of Higden—the one the most popular book in the philosophy of the age, the other in the history. Caxton, writing not a century after the time, says that he also translated the Holy Scriptures, but this is now matter of uncertainty. But there is no doubt that Wycliffe did translate the whole Bible, or gathered together translations which made an English Bible. Many copies of this volume were made about the time when it was completed, which was about a century before the introduction of printing into England. Wycliffe died in 1384.

Wycliffe's version of the Scriptures is deeply interesting, on account of the circumstances under which it was produced, and its connection with a favourite English name. It is of some importance in Biblical literature, as showing what Latin version was in his time regarded as of the highest authority in England, and also in what light certain questions in theology were viewed by that early Reformer. It is also curious as a monument of the state of the language in the middle of the 14th century. It was republished in 1850, under the editorial care of the Rev. Josiah Forshall and Sir Frederick Madden. The New Testament from this version was published by John Lewis, a clergyman of Margate, in 1731, reprinted under the care of Mr. Baber of the British Museum, in 1810; and in 1850, again printed from a contemporary MS. formerly in the monastery of Sion, Middlesex.

From the time of Wycliffe the authorities in the English church did whatever they could to discountenance the circulation of the Scriptures in the ordinary language of the people. It was regarded as a measure which was likely to produce heresies, and as a work which could never be executed with a sufficient degree of exactness. The time was, however, approaching when an opposition which was irresistible would be made to the church in this point.

It is to the resistance which was made by the ecclesiastical authorities of the time that we are to attribute the remarkable fact that, though the art of printing was introduced into England in or about 1474, yet no English Bible or Testament was printed till 1526, and then at a foreign press.

To William Tyndal we owe a translation of a large portion of the Scriptures into the English tongue, next in antiquity to Wycliffe's. Tyndal was acquainted with Luther, whose advice and assistance he is reported to have had in his translation. He lived much abroad, and before 1526 he had completed an English version of the New Testament. Of this he printed in that year two distinct editions; one in quarto at Cologne, another in duodecimo at Antwerp. Perfect copies of either of these editions are not known. The few imperfect copies which exist of this, the 'Editio Princeps' of the English New Testament, and very few they are, are treasured as the choicest book curiosities. Tyndal proceeded in his work of translation, and not less vigorously in superintending successive editions of his New Testament through the press. They were bought up and burnt in England; but this only supplied him with the means of printing other editions with such corrections and improvements as were suggested to him. He is said to have also printed a translation of the Pentateuch, and it is certain that he did translate those five books of Moses, and also many other books of the Old Testament. He did not, however, commit to the press any complete translation of the whole Scriptures. Tyndal was put to a cruel death at Filford, near Antwerp, where his translation first appeared in 1526. A reprint of this was issued at Andover in Massachusetts, U. S., in 1837, with the variations of Coverdale's, Matthew's, Cranmer's, the Genevan, and the Bishop's bibles.

Another person who at that early period engaged in the work was Miles Coverdale, a friend of Tyndal. He produced a complete English Bible, composed of Tyndal's translations, as far as they went, and his own. This was the first edition of the Bible in English. It was followed by several other publications of the English Bible in the interval between 1535 and 1611, when the present authorised version was first published. Of these we shall give a catalogue of the most remarkable, observing generally, that of each of these there were several distinct re-impressions, and of some of them many.

1. *Coverdale's Bible.*—This was printed at Zürich, it is believed, in 1535, and dedicated by Coverdale to Henry VIII. It was favourably received by the court. In the next year, Cromwell, the king's vicar-general and vice-gerent in ecclesiastical matters, enjoined that a copy of this translation should be laid in the choir of every parish church in England, for every one to read at his pleasure. A reprint of this was published in 1838, and again in 1847, with a memoir of Coverdale.

2. *Matthew's Bible.*—This also was printed abroad, but at the expense of two English printers, Grafton and Whitchurch: the date is 1537. The name of Thomas Matthew, whose edition it was said to be, is feigned. The real editor was John Rogers, the first person burned for heresy in the reign of Mary. The text is that of Tyndal and Coverdale slightly altered.

3. *The Great Bible, or Cranmer's.*—The Bibles hitherto published had been but the work of private persons. Cranmer, who was at that time archbishop of Canterbury, had, from the time when Coverdale's Bible appeared, been anxious to engage the bishops in the preparation of an English Bible, which should go to the people under their express authority. He found them not very eager to engage in the design. It is supposed that Coverdale had much to do in the preparation of this edition. The text is, in the main, the same with his. The preface was written by Cranmer. It was finished at the press of Grafton and Whitchurch in April, 1539.

4. *Taverner's Bible.*—This also appeared in 1539. The editor was Richard Taverner. The text is formed on that of Matthew's Bible.

There were eleven impressions of the English Bible in the reign of Edward VI., but they are considered as only reimpressions of one or other of the editions above mentioned.

5. *The Geneva Bible.*—During the reign of Mary, some of the divines who had been the most forward in promoting the Reformation took refuge at Geneva. Among these was Coverdale, who seems to have regarded the diffusing of the Holy Scriptures in the English tongue as his peculiar province in the labour of reformation. He and some other of the Protestant exiles, especially Gilby and Whittingham, set themselves to prepare another edition, to be accompanied with notes. They were employed in seeing it through the press when the death of Mary and the accession of Elizabeth opened a way for their return. Some remained behind to finish the work, which appeared in 1557. This long continued to be the favourite Bible of the English Puritans and of the Scotch Presbyterians. Not fewer than fifty impressions of it are known, and there were probably more. Both in the text and notes

there is a great leaning to the system of Calvin and Beza, with whom the exiles at Geneva were intimately acquainted. It scarcely deserves to be mentioned that this edition is often called the 'Breeches Bible,' on account of a rendering given in Genesis iii. 7.

6. *The Bishop's Bible, or Parker's,* so called from Matthew Parker, archbishop of Canterbury, first appeared in a large folio in 1568. Parker employed learned men to review the previous translations, and compare them with the originals. This edition exhibits, in consequence, some material variations.

7. *The Douay Bible,* of which the New Testament was first printed at Rheims in 1582, and the Old Testament at Douay in 1609–10. This is the Roman Catholic version. Cardinal Allen is understood to have had a principal share in this work.

This brings us to the period of King James's translation. Early in the reign of King James I. there was a conference of divines of different opinions at Hampton Court, for the settling the peace of the Church. In this conference much was said concerning the imperfections of the existing translations of the Scriptures. The king himself, who was often present at these meetings, expressed a strong opinion on that point of the debate. "I wish," said he, "some special pains were taken for a uniform translation, which should be done by the best learned in both universities, then reviewed by the bishops, presented to the privy council, and, lastly, ratified by royal authority, to be read in the whole church, and no other." Out of this speech of the king's arose the present English Bible; for the suggestion soon ripened into a resolution. As this is the Bible which has now for more than two centuries been the only Bible allowed to be read in the English Church, and as it is also the Bible universally used in dissenting communities, we may be expected to give a more extended notice of it than of the former editions. Fifty-four of the persons in that age most distinguished for that particular species of learning which such a duty required, were selected for the work, according to the king's suggestion: finally, forty-seven of them undertook it. They divided themselves into six independent classes, to each of which a certain portion of the work was assigned. Each person in the class was to produce his own translation of the whole committed to them: these several translations were to be revised at a general meeting of the class. When the class had agreed upon their version, it was to be transmitted to each of the other classes, so that no part was to come out without the sanction of the whole body.

Two of the classes sat at Westminster, two at Oxford, and two at Cambridge. The instructions which they received from the king were, that they should adhere to the Bishop's Bible, which was then ordinarily read in the churches, making as few deviations from it as possible. They were, however, to use the other versions, and to consult the translations which had been made into other modern languages; and they were to keep in the old ecclesiastical words, such as church, &c. When a word had divers significations, "that should be kept which had been most commonly used by the ancient fathers, being agreeable to the propriety of the place, and the analogy of faith." No marginal notes were to be used, except for the further explication of some Greek or Hebrew word. References to parallel passages might be given. They were to call in the assistance of any learned man who was known to have made the subject his study.

They were employed upon the work for three years, namely, from 1607 to 1610; proceeding with that deliberation and care which so weighty an undertaking required. The names of the divines engaged in it (and the portions are known which were committed to each class) are preserved. If we say that there are few names among them which have acquired a lasting celebrity, we are only saying of them what is the usual fate of divines. The name of Bishop Andrews is the first in place and first in celebrity. It is believed that Bancroft, then archbishop of Canterbury, though not one of the professed translators, had much to do in the superintendence of the work. It came forth from the press of Robert Barker in 1611.

This is then the great era in the history of the English Bible. From that time to the present there has been no serious intention entertained in the Church of any revision of this translation. It is admitted universally that it is in the main an admirable translation. But many persons in the Church have thought that, excellent as it confessedly is, it is not the best possible translation; and that it seems as if the time was arrived for revising the work of the divines of the days of King James, especially since the general principles of translation seem now to be better understood than heretofore, and the investigations of men of learning in the manuscripts of both the Old and New Testament in the originals have led to the establishment of a text which is allowed to make a nearer approach to the text as left by the original writers, than that which was used by King James's translators.

While, however, nothing has been done by authority, many persons have produced new and, as they presume, improved translations of particular books. Dr. Geddes, a Roman Catholic divine, but who had no particular attachment to his Church to influence him in his version, published a translation of the historical books of the Old Testament; and a translation of the Old Testament from the Septuagint version according to the Vatican text, with various readings from the Alexandrian copy, was published in 1842, by Sir L. C. L. Brenton. Lowth, bishop of London, and Dodson a learned layman, both published translations of the prophecy of Isaiah; Blayney, a translation of

the minor prophets; Stock, an Irish bishop, of the book of Job. Other translations of other books of the Old Testament have appeared, nor have there been wanting those who have attempted the too arduous task of translating the whole of these books. Numerous translations have been published of the New Testament, of which we may mention that by Gilbert Wakefield, and that by Newcome, the archbishop of Armagh. A new edition of the Greek text, with valuable notes, was published in 1854 by the Rev. H. Alford, who has since published translations of the Gospel according to St. John and Paul's Epistle to the Romans.

Still more numerous have been the editions of the English Bible in the version of King James, with notes, paraphrases, and practical expositions. Our limits will not allow of our entering upon an enumeration of these works. We must, however, name as works which are highly esteemed, Matthew Henry's 'Exposition of the Old and New Testament,' which originally appeared in 5 vols. folio, and has been often reprinted; the Family Bible, prepared by the Rev. Thomas Scott, rector of Aston-Sandford, in Buckinghamshire, a clergyman of what are called evangelical sentiments; the Commentary on the Bible by Adam Clarke, LL.D., a leading minister among the Wesleyan Methodists; the Family Bible of the Rev. Charles Wellbeloved, of York, a Presbyterian minister of Unitarian sentiments; and the 'Pictorial Bible,' with the commentary and illustrations by Dr. Kitto.

Modern translations into a vast variety of languages have been made, either of parts or the whole of the Old and New Testaments, which will be noticed under BIBLE SOCIETIES, by the exertions of which they have been chiefly effected.

BIBLE SOCIETIES. Associations, supported by voluntary contributions, for the general circulation of copies of the Sacred Scriptures, may be regarded as belonging peculiarly to the present century. Whatever had previously been done, either by societies or individuals, in the way of translating or printing the Bible, is insignificant when compared with what has been done since 1804. Previous to the formation of the British and Foreign Bible Society, the associations in Great Britain which included among their objects the circulation of the Bible were:—

1. The Society for the Propagation of the Gospel in New England, originally incorporated by an ordinance of parliament in 1649, and re-incorporated in 1661, after the Restoration. The missionary Eliot, known as the Apostle of the American Indians, after labouring to reduce the language of the tribes then surrounding the infant colony to writing, effected a translation of the Bible into it, which was printed in 1663 at the expense of the corporation. This edition of the Bible, which is dedicated to Charles II., contains the Psalms of David, attempted to be done into Indian metre, which Cotton Mather tells us were used in the congregations of the converted natives.

2. The Society for Promoting Christian Knowledge, established in 1698. It had caused an edition of the New Testament to be printed in Arabic, the whole of the Scriptures in Manx, and four editions of the Scriptures in the Welsh language.

3. The Society for the Propagation of the Gospel in Foreign Parts, established 1701. This and the preceding institutions were under the entire management of members of the Established Church.

4. The Society in Scotland for Propagating Christian Knowledge, incorporated in 1709. It distributed the Scriptures in Gaelic.

5. The Society for Promoting Religious Knowledge among the Poor, established 1750. The subscribers were entitled once in two years to copies of the Scriptures or other works published by the society, at a reduced charge.

6. The Bible Society, established in 1780, for the purpose of circulating the Scriptures among soldiers and sailors exclusively. In about twenty years it had distributed about 30,000 copies.

7. The Society for the Support and Encouragement of Sunday Schools, established in 1785. It provided the Sunday schools with copies of the Bible and Testament, and with spelling-books.

8. The French Bible Society, established in London in 1792, for the purpose of distributing copies of the Scriptures in France. This institution had made arrangements with a printer for an edition of the Scriptures in the French language, when its operations were entirely stopped by the Revolution. At the peace of Amiens it was discovered that the printer with whom the contract had been made, and who had received a sum of money on the society's account, had been ruined in the interval, and was unable to complete his engagements.

Such were the means in existence previous to the close of the last century for ensuring the general circulation of the Scriptures.

The most important of the above associations, in fact the only one which could attempt the circulation of the Bible on a large scale, was the Society for Promoting Christian Knowledge. Its efforts, however, do not appear to have been commensurate with the increasing demand. The following statement attributes to a tardiness in its operations the formation of the British and Foreign Bible Society:—

In 1787 a clergyman in London, who had been applied to for Bibles by a brother clergyman in Wales, wrote to the latter, stating that he had received twenty-five copies from the society for distributing Bibles among the soldiers and sailors; and that he was collecting money to send more, which he bought of the Society for Promoting Christian Knowledge, "who alone in London have got any Welsh Bibles." A year afterwards the same individual wrote to his corre-

spondent in Wales, stating that "there was a prospect of obtaining, through the assistance of another society, and with the help of Mr. T.'s purse, no less a number than 1000 Welsh Bibles; but the society, namely, the Society for Promoting Christian Knowledge, refuses to part with more than 500, and that at a price which altogether makes 5*s.* 6*d.* each. This has entirely defeated the design, so far as I am concerned in it."

Towards the close of 1791, a clergyman who had been visiting Wales alluded, on his return to London, to the scarcity of Bibles: "I heard great complaining amongst the poor for want of Bibles, and that there were none to be had for money." A fresh series of efforts was made in order to induce the Society for Promoting Christian Knowledge to publish another edition of the Welsh Bible; and a correspondence was entered into with the society, which may be seen in Dealtry's 'Vindication of the British and Foreign Bible Society.' The object of this correspondence was to induce the society to undertake an edition of 10,000 Bibles for circulation amongst the Welsh, and the applicants expressed their willingness "to take and pay for 5000 as soon as they were printed." At length, in July, 1792, terms were agreed upon with the society, and the wishes for a supply of Bibles seemed on the point of fulfilment. On the 29th of October, however, the individual who had conducted the negotiations with the society complained of its "dilatory, indecisive, and reluctant" conduct. The society could not be made to believe that "a large number of Bibles could be got off;" it seemed averse to incur the expense of a supply, although not likely to be more than from 1500*l.* to 2000*l.* In fine, the society surrounded the subject with so many difficulties that for the present it was reluctantly abandoned.

At length, in 1796, after an interval of about four years, during which, it may be presumed, the society continued to be urged on the point, an edition of the Welsh Bible, Common Prayer, and Singing Psalms, to the amount of 10,000, with 2000 extra Testaments, was ordered to be printed. In 1799 copies were ready for delivery, and the society liberally offered them on moderate terms. The whole of the edition was soon disposed of, as thirty years had elapsed since the last edition had appeared. The wants of the principality having however only been partially satisfied, the demand for Bibles on the part of those who had not participated in the recent supply became louder than before. Application was made in the year 1800 in order to ascertain if the society were disposed to undertake another edition. In 1802 the hope of engaging the society to enlarge the supply was abandoned. The plan of contracting for a supply of Welsh Bibles without the co-operation of the society was then agitated for the first time. It was suggested by the Rev. Thomas Charles, an ordained minister of the Established Church, but who was at the time officiating in the congregations of the Welsh Calvinistic Methodists. On the 7th of December 1802, the subject of the scarcity of Bibles in Wales having been introduced by Mr. Joseph Tarn in a circle of friends, Mr. Charles, who happened to be visiting London, and was present, proposed raising by voluntary contributions a sum sufficient for printing an edition. He insisted upon the urgency of applying to "new and extraordinary means" for effecting this purpose. In the course of the evening, the Rev. Joseph Hughes, a Baptist minister, suggested the outline of a plan for the *general* circulation of the Scriptures; and a call was made upon him to prepare an address in which the subject might be presented to public consideration. The matter was soon after laid before the late Mr. Wilberforce, Mr. Charles Grant, afterwards Lord Glenelg, and other men of like views. The Rev. C. F. A. Steinkopff, Lutheran minister at the Savoy Church in London, offered to make inquiries in the course of a Continental journey he was about to undertake, as to the circulation of the Scriptures in that quarter. A similar course was contemplated with respect to Great Britain and Ireland.

The occurrences detailed above took place prior to the end of May 1803. By this time the appeal which Mr. Hughes had been called upon to prepare was finished. Its title was, 'The Excellence of the Holy Scriptures, an Argument for their more general Diffusion.' The rudiments of the Bible Society were developed in this address, and having been extensively circulated, it was deemed, in the month of January 1804, that a sufficient period had elapsed for the discussion of its merits, and that the time had arrived for putting the plan into activity. Samuel Mills, Esq., who had prepared an outline in the preceding year, now completed the details of the plan. The projected society had at first received the name of the "Society for Promoting a more extensive Circulation of the Scriptures both at Home and Abroad;" but it was now changed to that of "The British and Foreign Bible Society."

On Wednesday, March 7th, 1804, a public meeting, convened by a circular address, was held at the London Tavern, Bishopsgate Street, to discuss the means of forming the society. The attendance consisted of about 300 individuals of various religious denominations. The first and second resolutions moved were as follow: 1. "That a society shall be formed, with this designation, the 'British and Foreign Bible Society,' of which the sole object shall be to encourage a wider diffusion of the Holy Scriptures." 2. "That this society shall add its endeavours to those employed by other societies for circulating the Scriptures through the British dominions; and shall also, according to its ability, extend its influence to other countries, whether Christian, Mahometan, or Pagan." Seven other resolutions relating to the organisation of the

society were passed unanimously. A committee was formed, 700*l.* were at once subscribed, and the institution was considered to be fairly in existence.

On the 12th of March 1804, the committee met to complete the organisation of the institution. The thirty-six individuals composing the committee comprised men of various religious opinions. It must be confessed that they were surrounded with considerable difficulties. Every step, in fact, was on delicate ground; and this was more especially manifest when an individual proposed the appointment of the Rev. Joseph Hughes to the office of secretary. This motion was opposed by the Rev. J. Owen, afterwards one of the secretaries and the historian of the Bible Society, who insisted in strong terms on "the impropriety and impolicy of constituting a dissenting minister the secretary of an institution which was designed to unite the whole body of Christians, and for which its directors had evinced so laudable an anxiety to obtain the patronage and co-operation of the Established Church." The individual who had moved Mr. Hughes's appointment, as well as the committee generally, saw the propriety of Mr. Owen's objections; but it was fortunate that the opportunity had arisen which called them forth, as they led to an arrangement, the principle of which was at once so judicious and liberal, that when acted upon, as it has been in all the movements of the society, it has constituted one of the chief corner-stones of its stability and success. It was accordingly moved, that the Rev. Josiah Pratt, B.D., the secretary to the Church Missionary Society, who had been pointed out by Mr. Owen as a fit individual, should be appointed secretary, in conjunction with the Rev. Mr. Hughes. The creation of another office was then suggested, in order that the foreign churches might be represented in the society; and the Rev. Mr. Steinkopff was appointed foreign secretary. Thus, as Mr. Owen remarks, "the progress of an hour carried the committee on from the hasty suggestions of a short-sighted attachment to the wise determination of a liberal policy." To prevent the operation of temporary feeling in the appointment of the governing body, the future proportion of Churchmen, Dissenters, and foreigners on the committee was distinctly defined. This body was to consist of thirty-six individuals, namely, six foreigners, resident in or near the metropolis, fifteen Churchmen, and fifteen Dissenters,—the whole of the thirty-six being laymen. The clergymen and ministers generally had a seat and vote on the committee on the same terms by which they became members of the society. Mr. Pratt having voluntarily resigned his office, Mr. Owen was appointed secretary in his place.

On Wednesday, May 2nd, 1804, a general meeting of the subscribers and friends of the institution took place, at which Lord Teignmouth was appointed president of the institution. On the 5th of May, the bishops of London, Durham, Exeter, and St. David's recognised the society by sending in their names as subscribers, and in June they accepted the office of vice-presidents.

Such was the formation of the British and Foreign Bible Society; and its subsequent history involves that of all similar institutions which it has called into existence in every part of the world. In Germany, as early as 1712 the Baron von Canstein instituted an establishment at Halle for the purpose of furnishing the Bible at as cheap a rate as possible: and this it did with remarkable success, its issues of complete Bibles exceeding three millions, and of the New Testament more than two millions. The first foreign Bible society was formed at Nürnberg in 1804: but the seat of its operations was afterwards transferred to Basel. This was termed the German Bible Society. In 1805 a society was established at Berlin, which afterwards, in 1814, became merged in the national institution of the Prussian Bible Society, which has now distributed more than two million copies of the Scriptures. Notwithstanding the war, which for a time would appear to have presented a formidable obstruction to the progress of such associations, the continent of Europe may be described as having become in a few years literally covered with Bible societies. In St. Petersburg the Russian Bible Society was established, not merely with the sanction, but by the formal authority of the Emperor Alexander, during the year 1813. After the accession of the Emperor Nicolas, the operations of this society, and of all its auxiliaries, amounting in number to 289, were suspended by an imperial ukase. The motives which led to this do not distinctly appear; though probably arising from the dissensions amongst the hierarchy of the Greek Church, numbers of whom viewed with jealousy the efforts which were making to disseminate the Scriptures; but permission was afterwards given to establish a *Protestant* Bible Society, for the purpose of supplying the Protestants in Russia with the Scriptures. The Russian society had however done good work, for they had caused the Bible to be translated into thirty-one languages and dialects of people living under the Russian government. A society was formed in Paris in 1818; this now exists under the title of the French Protestant Bible Society. In the report made by it on May 4, 1859, it is stated that there had been issued in the year, 13,448 volumes; that the income of the society had been 45,000 francs, a considerable increase over the preceding year; and that small pocket stereotype editions of the New Testament were being prepared for the use of soldiers and sailors.

There are at present societies or agents at Toulouse, Frankfort, Colmar, Mühlhausen, various places in Switzerland, Würtemburg, Saxony, at Warsaw, Cologne, Elberfeldt, Neuwied, Geneva, Dorpat, in Sweden, Norway, and Denmark, in Belgium, and Holland. In Spain,

Portugal, and Italy efforts have been made to introduce the Scriptures, but in 1816 a popish bull was issued forbidding the diffusion of the Bible among the people as dangerous; and in 1817 another was issued forbidding the establishment of Bible societies. In more recent years, individuals in Italy have been proceeded against, and even imprisoned, for having a Bible in their possession. In the Austrian dominions, also, in the same year (1817), the distribution of Bibles and the establishment of Bible societies were forbidden. Agents are also in Greece, and at Smyrna, Bucharest, Constantinople, Damascus, Astrachan, Selinginsk, Tunis, &c., exclusive of the extensive connexions of the society throughout the British dependencies in every quarter of the world.

In the United States of America, the first society which was formed was the Philadelphia Bible Society, in 1808. This example was imitated in numerous other places of the Union; and in 1816 the idea of a general national institution was carried into execution by the establishment of the American Bible Society. There are now there upwards of 1000 establishments distinguished as ladies' societies.

It will be unnecessary to trace further the progress of the formation of other societies in different parts of the globe, the details being in all cases similar. We therefore return to the immediate history of the British and Foreign Bible Society.

The first application of the society's funds to printing the Scriptures in a foreign language took place in 1804, when 2000 copies were proposed for circulation among the Mohawk Indians. At this time the foundation was laid of a library, which has become by frequent accessions a valuable and curious collection of biblical literature. The society was very early called upon to exercise its judgment and discretion in regulating the movements which it had produced. It had adopted from the first, as a fundamental principle, the resolution of circulating only the authorised English version of the Scriptures without note or comment. The individual who proposed the Mohawk version was well known to the Indians, and thinking to prepare for the more favourable reception of the Scriptures among them, he wrote an address every way calculated to effect this purpose, which he caused to be pasted inside each copy. The society, in strict adherence to its conviction of the duty of circulating the Scriptures alone, was compelled to suppress the excellent address which had been prepared. The prudence, good sense, and moderation of the committee of the Bible Society, exercised at this period, when it might have been anticipated that it would have been anxious to awaken the enthusiasm rather than repress the zeal of its supporters, have throughout its whole career formed the most remarkable characteristics of its proceedings.

Yet notwithstanding the general care and prudence of the committee, a deviation from the strict letter of the fundamental rule, which permits only the circulation of the authorised version, raised a controversy which at one time appeared to threaten the stability of the society. About the year 1821 it began to be intimated publicly, that the committee had been in the practice of permitting the apocryphal books to be intermingled in such copies of the Scriptures as were furnished to foreign societies. The staunch friends of the authorised version *exclusively* took up the matter very warmly, especially in Scotland; the controversy was carried on with much heat and acrimony; and (a natural consequence in all such controversies) the original accusation was not allowed to stand alone. Complaints were made of mal-practices in the expenditure of the society's funds; the correctness of many of the translations of the Scriptures made under the direction of the committee was impugned; and other matters were laid to the charge of the managers of the society, all of which combined led to a secession of many auxiliary societies, and weakened for a time the authority and influence of the parent society. The committee, in 1826, brought forward the following resolutions: "1. That the fundamental law of the society, which limits its operations to the circulation of the Holy Scriptures, be fully and distinctly recognised as excluding the circulation of the Apocrypha. 2. That in conformity to the preceding resolution, no pecuniary aid can be granted to any society circulating the Apocrypha; nor, except for the purpose of being applied in conformity to the said resolution, to any individual whatever. 3. That in all cases in which grants, whether gratuitous or otherwise, of the Holy Scriptures, either in whole or in part, shall be made to any society, the books be issued bound, and on the express condition that they shall be distributed without alteration or addition." Confidence has been gradually restored since these resolutions were acted upon; and the society is now (1859) in a higher state of activity and prosperity than it has ever enjoyed since its foundation.

It would have been utterly impossible for the Bible Society to extend its operations into every corner of the globe unless its resources had been increased by the various branches into which it ramified. These branches have communicated life and energy to the parent stem from the most remote and distant quarters. The growth of societies whose operations were auxiliary to those of the original institution does not appear to have been very rapid. In March, 1805, the first Bible association was formed at Glasgow; in July, an association was formed in London; and in April, 1806, one was formed at Birmingham. These associations had not a separate and distinct existence, and possessed no independent forms of government; they were simply unions of a few individuals whose contributions were devoted to the parent society. In proportion as the system of which they formed a part

gathered power and influence, they necessarily assumed a more important character. As auxiliary societies, although still in connection with their prototype, their functions and exertions became more individual and local in their nature.*

The first auxiliary Bible society was established on the 28th of March, 1809, at Reading. It adopted the regulations of the parent society. On the 30th of the same month, auxiliary societies were established at Nottingham and Newcastle-upon-Tyne. The Edinburgh Society was established July 31; and similar institutions were formed in East Lothian, Leeds, and Exeter, on the 4th of October, 25th of October, and 8th of December, respectively. The first auxiliary institution, established in the year 1810, was at Manchester. An auxiliary Bible society was formed at Kendal on the 5th of January; one at Bristol on the 1st of February; one at Sheffield on the 5th; one at Leicester on the 19th; and the Hull Auxiliary Society was established April 4th. Eleven of these institutions had been established previous to the sixth anniversary of the parent society. The public nature of the proceedings connected with the establishment of these societies occasioned the claims and merits of the institution to be much more generally known and acknowledged: and the formal recognition of its value and importance, made by men of high character and influence residing in those vicinities where local societies arose, added to the authority and consequence with which the Bible Society began to be invested, and, with other circumstances, tended greatly to enlarge its resources and increase the magnitude of its operations. The formation of juvenile and female Bible societies contributed to multiply the efforts of the Society for the circulation of the Scriptures. By means of these subdivisions, which were subordinate to their own local institution, a wider sphere of action and personal influence was created, the benefit of which extended throughout the whole system. The scholars of Holborn Sunday-school, who contributed 1*l.* 17*s.* at the eighth anniversary of the parent society in 1812, offered the first example of the young appearing as contributors to the society. The York Juvenile Bible Society, the first institution of the kind, was formed during this year, which was further distinguished by the establishment of the first Ladies' Auxiliary Society. It is right, however, to mention, that at New York, U. S., in 1809, there had been formed the Young Men's Bible Society; and at Sheffield, in 1805, when the existence of the British and Foreign Bible Society was unknown to the parties, a female association existed, whose object was the circulation of the Scriptures.

The projectors of the Bible Society not having foreseen the origin and progress of the auxiliary institutions, had made no provision for their uniform regulation; but their number had become so considerable in 1812 that the subject was forced upon them, and in the spring of that year an address was prepared, entitled, 'Hints on the Constitution and Objects of Auxiliary Societies,' the object of which was to effect the consolidation of the auxiliary societies on a just and uniform basis. In 1812 the objects and interests of the Bible Society were ably promoted by the circulation of the following tracts: 1. 'On the Advantages of Distributing the Holy Scriptures among the Lower Orders of Society, chiefly by their own agency,' by Mr. Dealtry. 2. 'An Appeal to Mechanics, Labourers, and others, respecting Bible Associations,' by Mr. Montgomery, of Sheffield. 3. 'On the Influence of Bible Societies on the Temporal Interests of the Poor,' by Mr. (afterwards Dr.) Chalmers.

The expenditure of the Bible Society, from the commencement of the Institution up to the 31st of March, 1858, has been 4,646,267*l.* 5*s.* 2*d.*, and they have issued from London 11,681,886 Bibles, or portions of the Old Testament, and 12,849,108 New Testaments, or portions of the same. On various parts of the Continent, by means of the branches of the Society and the employment of colporteurs, they have distributed 1,877,468 Bibles and parts of the Old Testament, and 7,575,484 New Testaments, or parts of it; a total of 33,983,346. The income of the Society for the year ending March, 1858, was 152,574*l.*; of which 79,041*l.* was derived from subscriptions, donations, legacies, interest on funded property, &c.; 70,267*l.* from receipts for Bibles, Testaments, and draw-backs of duty; and 2766*l.* from special contributions to a Chinese New Testament and India Fund. The total expenditure for the year was 153,177*l.*, and the society was under engagements to the amount of 83,818*l.* The abstract of the report for the year ending March 31, 1859, shows the total receipts to have been 154,906*l.*, of which 76,859*l.* had arisen from the sale of Bibles, Testaments, &c. The expenditure during the year had been 158,642*l.*, and the number of volumes issued was 1,625, 985, a large increase on previous years on all the items.

These immense resources were derived, in a great measure, from the exertions of the affiliated societies. In 1858, the total number of auxiliary societies was 629; of branches, 743; and of associations, about 1800. Of these, according to the Fifty-fourth Annual Report, there were 524 auxiliary societies in England and Wales, and 402 branches. In Scotland, 27 auxiliaries and 4 branches; in Ireland, two auxiliary societies only. In the British colonies and dependencies, there were 17 auxiliary societies in North America, and 263 branches; in the West Indies, 25 auxiliaries and 3 branches; in Asia, 7 auxili-

* Auxiliary societies are allowed to purchase Bibles and Testaments at prime cost; their members have the same privileges also, at the local depositories, as the members of the parent society enjoy in London.

aries and 13 branches; in Australia, 13 auxiliaries and 39 branches; and in Africa, 9 auxiliaries and 19 branches. In Europe, there were auxiliary societies in Florence, Lucca, Hamburg, Constantinople, and Gibraltar.

The society have adopted a system of colportage (a kind of licensed hawker) in many parts of the Continent. In 1857-8 they forwarded 17,300 Bibles and 57,900 Testaments to France, of which 17,200 copies had been distributed in this way. The books are sold at a loss, and the expense of the hawking has been more than 3000*l.*; but they consider the effects produced as very encouraging. In Belgium, 8000 copies of the Scriptures, either wholly or in parts, were distributed. In Holland, 22,233 Bibles were distributed, of which 2590 copies were given to schools, and two editions of the Bible in Dutch have been specially printed for them. In Germany, from the Society's three great centres, Berlin, Cologne, and Frankfort, 296,607 copies of the Scriptures were issued; making a total, since 1847, of 858,926 copies, either complete or in portions. In Denmark, 5774 copies were issued, and two large editions had been printed in Danish. In Sweden, 86,518 copies of the Scriptures, in Swedish or Finnish, were distributed; and in Norway, 18,957. In Russia, 12,290 copies of the Scriptures were distributed, chiefly through the Petersburg agency; and 10,000 Finnish Testaments and 10,000 copies of the Psalms were printed. In Switzerland and Northern Italy, 35,269 volumes had been distributed; in Sardinia, 13,647, in a great measure by colportage. In Malta and Greece, 8398 volumes had been put in circulation. In Turkey, in various languages, 10,836 copies of the Scriptures were distributed. In Spain nothing had been done, but an edition of the New Testament in Spanish had been completed, and some copies had no doubt got in from Gibraltar.

For India, Ceylon, Singapore, and China, either the whole or portions of the Holy Scriptures had been printed in the various dialects for the use of the inhabitants. At Shanghae, 50,000 Chinese Mandarin colloquial New Testaments had been printed during the year.

In all these places (except Spain) the efforts of the British Bible Society have been effectually aided by similar native institutions in Europe, and by the United States' societies in China and Australasia.

The number of auxiliary societies in connexion with the American National Bible Society is 863. The Philadelphia Bible Society, the oldest institution in the United States, has also its various branches.

On the continent of Europe the Society has printed, or extensively aided in printing, versions of the Scriptures into the French, Basque, Breton, Flemish, Spanish, Catalonian, Portuguese, Jewish-Spanish, Hebrew, Italian, Romanese, German, Bohemian, Servian, Wendish, Hungarian, Polish, Lithuanian, Danish, Swedish, Finnish, Lapponese, Icelandic, Samogitian, Esthonian, Lettish, Sclavonian, Wallachian, Albanian, Russian, Turkish, Turco-Greek, Tartar Turkish, Modern Greek, Calmuc, Buriat Mongolian, Manuchod, Modern Armenian, Carshun, Syriac, Georgian, Turco-Armenian, and Armenian languages. In Asia it has promoted the translation and publication of the Holy Scriptures in Persian, Arabic, Singalese, Pali, Hindostanee, Bengalee, Sanscrit, Teloogoo, Tamul, Malay, Mahratta, Malayalim, Orissa, Seik, Birman, Carnarese, and several other dialects, together with two versions of the whole Scriptures in the Chinese, a language understood by perhaps one-fifth of the population of the globe. At Madagascar the New Testament and Psalter have been printed in Malagasse. In New Zealand the Bible has been rendered into the Maori tongue. The inhabitants of the Society and Georgian Islands have also received versions in the Tahitian languages, as well as other of the island groups in the Pacific. In Africa the ancient Church of Abyssinia has been supplied with an edition of the Ethiopic Psalter and the Gospels; and the Pentateuch, Psalter, and New Testament have been printed in the vulgar dialect of Abyssinia. Egypt has been furnished with the Psalter and the four Gospels in Coptic and Arabic. The inhabitants of a portion of Western Africa have received a part of the Scriptures in the Bullom dialect; the aborigines of Northern Africa, a translation of the Gospels and the book of Genesis in the Berber; some of the tribes of Southern Africa, the Gospels in the Namacqua dialect, besides versions in the Caffre and Sechuana. At Labrador the New Testament and Psalms have been translated into the Esquimaux language, and the New Testament and the book of Genesis into the language of Greenland.

By the Serampore missionaries.—Bhojpooree, Budrinathee, Bulochee, Bundelkhundee, Huriyana, Joypore, Munipoora Koonkee, Tripoora Koonkee, Kousoulee, Kucharee, Kutch, Mithilee, Oodoypore, Sindhoo, and Southern Sindhoo.

The Society for Promoting Christian Knowledge, though its exertions are not confined to the issue of Bibles and Testaments, but range over a wide field, is only second to the British and Foreign Bible Society in the amount of the distribution of the Holy Scriptures. The annual diffusion of these averages over 200,000. In 1857-8, the society issued 146,270 Bibles, 69,166 New Testaments, and 300,155 Common Prayer Books, besides other books and tracts amounting to 3,700,000. The society, also, at a special general meeting, held February 10, 1834, appointed a separate committee for the purpose of superintending the publication, and more effectually promoting the circulation of the Scriptures in foreign languages. In the report for 1858, it is stated that "the committee have issued translations of the Bible in French, Italian, Dutch, German, Spanish, and Arabic. The New Testament has been published in Maltese, Polish, and Ojibwa. The Psalter in Arabic, and triglot Psalters in French, English, and German, and in Italian, English, and Spanish, have been for some time in circulation; and a Greek Psalter, from the Septuagint, has been recently added to the catalogue. The Gospel according to St. Matthew, in the language of New Zealand; and the Gospels and part of the Acts together with a portion of the Book of Genesis, in the language of the Arawack Indians have been published. A translation of the Acts of the Apostles, in the language of the Zulu Kafirs, has been printed at the request of the Bishop of Natal. The New Testament in Coptic and Arabic has been published. The Prayer Book has been produced in French, Dutch, German, Danish, Italian, Spanish, Portuguese, modern Greek, modern Armenian, Maltese, Arabic, Turkish, Amharic, New Zealand, Ojibwa, Muncey, and Cree (North American Indian); and the orders for Morning and Evening Prayer, in the Soosoo language, have just been issued for the immediate use of the newly-established mission on the river Pongas in Western Africa." The expenditure of the society for the year, except for the working expenses of the establishment, was nearly altogether on the production of Bibles and other books, and it amounted to 80,748*l.* The receipts from sale of books was 59,520*l.*, and the deficiency is amply made up by subscriptions and the interest of the accumulations. Like the Bible Society it employs foreign and colonial agencies to promote the diffusion of the Scriptures, and it has recently formed a special fund for India.

(Owen's *History of the Bible Society; Reports of the British and Foreign Bible Society; Reports of the Society for Promoting Christian Knowledge.*)

BIBLIO'GRAPHY. The term Βιβλιογραφία was used by the Greeks to signify only the writing or transcription of books; and a bibliographer (Βιβλιογράφος) with them was a writer of books, in the sense of a copyist. The French term *Bibliographie* was long used to signify only an acquaintance with ancient writings and with the art of deciphering them. It is so explained, for instance, in the edition of Richelet's 'Dictionary,' published in 1732. The term *bibliographe* (bibliographer) is not in Richelet. It is given, however, in the 'Encyclopédie' (Paris, 1751); but both it and *bibliographie* are still explained only in the sense that has been just noticed. In the 'Dictionnaire de Trévoux,' published in 1752, we find it stated that a bibliographer is a decipherer of ancient manuscripts, with the addition, that now-a-days the name is given specially to those who are skilled in the knowledge of books and their editions, and who make catalogues of them. Accordingly, in 1763, De Bure published the first volume of his well-known work on the knowledge of rare and singular books, under the title of 'Bibliographie Instructive.' In his preface he employs the term as if the acceptation which it bears in his title-page had become familiar. In subsequent editions of the 'Encyclopédie' (for instance in the fifth volume of the Lausanne edition, printed in 1778) a new article appears on the term *bibliographie*, which consists merely of a notice of this book of De Bure's. We doubt whether the English term *bibliography*, which we have borrowed from the French, has ever had any other than this signification since its first appearance in the language.

Bibliography may be defined to be the science of books, regarded simply as such. Thus limited, it excludes all consideration either of the literary merits of a work, or of the importance or interest of the subjects which the author treats of, or of the truth or value of his statements, opinions, or speculations. It comprehends the facts—of the subject and class of the work, of its authorship and subsequent history, of the number of editions it has passed through, of the printer and publisher of each, and of its date in respect both of time and place, of the form or size (that is, the manner in which the sheets are folded, and also the size of the sheet, for the old folios are often small, such as some old editions of Bale), the quality of the paper, the number of pages, the typographical character, the number and description of the plates, the comparative completeness, correctness, and rarity, and all other external peculiarities or distinctions, of each edition. It is common to include many other things as parts of bibliography, such as a knowledge of the history, and even of the processes of the arts of printing and book-binding, as well as of the written characters of different ages. But to give such an extension to the science is to leave it without any limits whatever. If the knowledge of the art of deciphering written characters, for instance, is to be held to be a part of bibliography, then the bibliographer must be a universal linguist, in so far at least as respects the alphabets of all languages. If bibliography, again, is to include a knowledge of the arts of printing and bookbinding, why not also of those of the making of paper, parchment, papyrus, and all other substances that have ever been used for printing or writing upon, and of the composition and manufacture of inks and all other pigments? In this way bibliography would include no inconsiderable portion both of chemistry and botany. On the same principle the bibliographer might be required to have a knowledge of everything appertaining to the arts of cutting letters in wood and stone.

Although bibliography, in the sense to which it is now confined, is a very modern term, the science of the knowledge of books in regard to their authors, subjects, editions, and history, must have been cultivated from a comparatively early period in the history of literature. Indeed an acquaintance with such matters is to a great degree implied in a general knowledge of literature, such as must have been possessed by

many persons in every age of civilisation and learning. But the study must have been more systematically pursued, even in the ancient world, by those whose business it was to arrange and take charge of large libraries, of which we know that many, both public and private, existed in Greece, in Egypt, at least under the Ptolemies, in Italy, and in other countries. The principal booksellers of those days must also have been more or less conversant with what we now call the science of bibliography. We believe, however, that no professed treatise upon the subject, or upon any part of it, has either come down to us from antiquity, or is anywhere mentioned among the now lost productions either of Greek or Roman learning.

It is only since the invention of printing, and the consequent extraordinary multiplication of books, that bibliography has, properly speaking, assumed the form of a science, and been developed in its principles and details in systematic works.

In Germany, in Italy, in France, and also in our own country, works in all the departments of bibliography have, within the last three centuries, been produced in such numbers that the mere enumeration of their titles would make a bulky volume. We can here notice only a very few of the most important, and that chiefly for the purpose of illustrating the different branches into which the subject may be divided.

The most numerous class of bibliographical works are lists or catalogues of books; but these are of various descriptions. Even booksellers' catalogues are to be included under this head; such catalogues are collected and prized by bibliographers, as in many cases affording evidence both of the prices of books and of the existence of particular editions and copies. Some of them, from the superior rarity of the articles which they include, or from bibliographical notices with which they are interspersed, have a much higher value. The 'Bibliotheca Anglo-Poetica,' for instance, published in 1815 by Messrs. Longman and Co., is perhaps the fullest list that exists of the earlier and rarer productions of English poetry, of many of which it also contains interesting bibliographical descriptions. Under the same head may be mentioned such publications as Reed's 'Bibliotheca Nova Legum Angliæ' (1809), and other catalogues of law-booksellers, in which legal works are classified according to their subjects. Among the most valuable sale catalogues, however, are some of those of the libraries of individual collectors; such, for example, as that of the late Mr. Roscoe (prepared by himself) and published in 1816, those of the libraries of Dr. Parr (1827), of Mr. Heber (1834), of the Rev. H. F. Lyte in 1849, but which contains little more than a literal reprint of the titles arranged alphabetically according to the author's names; and above all, that of M. Libri (1859), which contains a large amount of valuable information. Among the older English catalogues of the libraries of private individuals, one of the scarcest is that of the large library of Mr. Thomas Rawlinson, which was dispersed by auction in 1722. This catalogue was published in parts, and is rarely to be found complete. Rawlinson is the person satirised under the name of Tom Folio, in the 158th number of the 'Tatler.' Some of the most celebrated of the foreign catalogues of this description are those of the libraries of M. Cisternay du Fay (8vo, 1725), of the Comte de Hoym (8vo, 1728), of the Abbé Charles d'Orléans de Rothelin (8vo, 1746), and of M. Claude Gros de Boze (8vo, 1753), all prepared by the Parisian bookseller, Gabriel Martin. There is another catalogue of the library of M. de Boze, printed under his own care at the royal press in small folio in 1745, which is of extreme rarity, only fifty copies, it is said, having been thrown off. De Bure states that a single copy has been sold for nearly 240 livres. In all these catalogues of Martin's the books are arranged in classes according to a scheme of his own contrivance, and an alphabetical catalogue of the names of the authors is given at the end. Perhaps, however, the most comprehensive and valuable catalogue thus digested that has ever been published is that entitled the 'Bibliotheca Bunaviana,' 7 vols. 4to, Leipzig, 1748-1756, being a catalogue of the library of the Count de Bunau, drawn up by his librarian, Jo. Mich. Franck. The divisions and subdivisions in this catalogue are much more numerous than those in Martin's system. The work has the highest character for accuracy, so far as it goes: but unfortunately it never was completed.

Some 'Catalogues Raisonnés' (as catalogues in which the books are thus disposed into classes according to their subjects are called by the French) have also been printed of public libraries. The greatest work of this description is probably that of the French 'Bibliothèque Royal,' begun in 1739, and finished in ten volumes folio in 1753. This catalogue consists of two parts, one of the printed books, and another of the manuscripts. The former was originally superintended by the Abbés Sallier and Boudot, the other by Anicet Mellot. The most complete catalogue of this description in existence is understood to be that of the library of the university of Gottingen, but it has not been printed. (See an account of this Catalogue in the 'Quarterly Journal of Education,' No. IV.) The best specimen of a 'Catalogue Raisonné' that we know of any of the more considerable public collections of this country, is that of the library of the Writers to the Signet in Edinburgh, published in one volume quarto in 1805. The catalogues of the libraries of some mechanics' institutes and other private associations have more recently been published upon a similar plan. That of the London Institution in Finsbury Circus, is an excellent specimen; the works are classified and described in the body, and there are two indexes, one of subjects,

and one of authors and books, arranged alphabetically. It is to be observed that a 'Catalogue Raisonné' implies something more than a distribution of the books into so many distinct alphabets, severally headed Theology, History, Voyages and Travels, Novels and Romances, Poetry, Medicine, Law, &c., as we find done even in many catalogues of circulating libraries, and booksellers' and auctioneers' sale catalogues. In a 'Catalogue Raisonné,' properly so called, the alphabetical arrangement of titles is entirely dispensed with, its place being supplied by an index at the end; and every work is set down in the order pointed out by its subject, the ground over which the author's researches or speculations extend being at the same time indicated as distinctly and fully as possible, not only by the transcription of the title-page, but, when necessary, by an abstract of the contents. This is especially done in the case of publications that consist of collections of treatises.

There are printed catalogues of most of the public collections of books in this country; but, with the exceptions just mentioned, they are all, we believe, merely alphabets of titles, and even as such few of them have been very carefully drawn up. One of the most inaccurate and deficient is the old catalogue of the printed books in the general library of the British Museum, which was published in 1813-1819, in seven octavo volumes. That of the Royal Library, in the same depository (five volumes folio, besides a catalogue of maps, prints, &c., in one volume, 1820-1829), was prepared with much greater care. The great manuscript catalogue in the Reading-room of the British Museum will, when completed, be probably the finest catalogue in Europe. There are also excellent printed catalogues of the Harleian, Cottonian, Lansdowne, Sloane, and Birch manuscripts, all preserved in this extensive national collection.

A higher description of catalogues are those not of particular collections, but of books generally, or of certain classes of books, arranged in reference either to their subjects, their dates, their authors, or their titles.

One of the earliest attempts made to present in this way what we may call a complete survey of printed literature was that of Conrad Gesner, in his 'Bibliotheca Universalis,' published in one volume folio in 1565. In this catalogue the works are arranged according to the names of the authors; but although designated an universal library, it is confined to books in the Greek, Latin, and Hebrew languages, which, although comprehending by far the greater part, did not even then include the whole of literature. Gesner, however, remains to the present day without any successor in his vast enterprise. No subsequent work has appeared professing to survey in the same manner the whole field of existing literature. The nearest approach that has been made to anything of the kind is in the 'Bibliotheca Britannica' of Dr. Robert Watt, of Glasgow, four vols. 4to, Edin. 1824. This is a most elaborate, meritorious, and useful work; but, as its title indicates, it is to be considered as aiming at completeness only in regard to English works; those which it notices in other languages, although also amounting to a very large number, being professedly only a selection. Owing also to the residence of the author in a remote provincial town, where he was precluded from access to many of the most valuable sources of information, his work is neither so full nor so correct as with better opportunities it might have been made; and some additional inaccuracies have crept into it from his not having lived to see it through the press. With all these drawbacks, however, it is still an extraordinary monument of industry, and a help to the student of very great value. It consists of two parts, in the first of which the books are arranged according to the names of the authors, and in the second alphabetically according to their titles.

In a few cases attempts have been made to present catalogues of all the works written in some single language, or by the authors of some single country. As examples of catalogues of this description may be mentioned the 'Illustrium Majoris Britanniæ Scriptorum Summarium' of John Bale, first published in 1458 (for an account of which see BALE, JOHN, in BIOG. DIV.); the 'De Academiis et Illustribus Angliæ Scriptoribus' of John Pits, the first volume of which (the only one ever published) appeared at Paris, in 4to, in 1619; the 'Bibliotheca Britannico-Hibernica' of Bishop Tanner, folio, 1748; the 'Bibliotheca Belgica' of John Francis Foppens, 2 vols. 4to, 1739; and the 'Bibliotheca Hispana, Nova et Vetus,' 4 vols. folio, 1672 and 1696, of Nicholas Antonio. Under this head also may be mentioned the several admirable works of John Albert Fabricius, entitled the 'Bibliotheca Latina,' 2 vols. 4to; the 'Bibliotheca Mediæ et Infimæ Latinitatis,' 6 vols. 4to; and the 'Bibliotheca Græca,' the second edition of which, by Harles, published at Hamburg in 1790-1809, is in 12 volumes, 4to. Dr. Dibdin's 'Introduction to a Knowledge of Rare and Valuable Editions of the Greek and Roman Classics,' first published in 1802, has been several times reprinted, but is not of any great value.

A much more numerous class of catalogues are those of all the books written either in some one language, or in all languages, upon a particular department of knowledge. Thus we have the 'Bibliotheca Theologica,' the 'Biblictheca Juridica,' the 'Bibliotheca Philosophica,' and the 'Bibliotheca Medica,' of Martin Lipenius, or the whole collected in six volumes, folio, under the title of 'Bibliotheca Realis.' To the 'Bibliotheca Juridica' valuable supplements were added by Scholt in 1775, and by Seckenberg in 1789, which have increased the work to four volumes folio. One of the very best of this class of works is the great French work by the Père Le Long, entitled 'Bibliothèque Historique

de la France,' an account of works both printed and manuscript on French history, the last edition of which, published at Paris in 1768-1778, is in five volumes folio. The 'Bibliotheca Historica' of Meusel, published at Leipzig in 1782-1804, in twenty-two volumes, 8vo, is much more extensive in its design, comprehending both historical and geographical works relating to all countries and in all languages. Other works of this class are the 'Bibliotheca Magna Rabbinica' of Julius Bartoloccius, 4 vols. fol. Rome, 1675, with the supplement of C. J. Imbonatus, fol. Rome, 1694; the 'Scriptorum Ecclesiasticorum Historia Literaria' of Cave, 2 vols. fol. Oxford, 1740; Luke Wadding's 'Scriptores Ordinis Minorum,' fol. Rome, 1650 (a highly esteemed and scarce work); Ribadeneira's 'Bibliotheca Scriptorum Societatis Jesu,' fol. Rome, 1676; Le Long's 'Bibliotheca Sacra' (an account of the editions of the Scriptures, and of the versions of them in various languages), 2 vols. fol. Par., 1723; the 'Bibliotheca Scriptorum Veterum et Recentiorum' of J. J. Manget, 4 vols. fol. Geneva, 1731; the Rev. T. H. Horne's 'Manual of Biblical Bibliography,' 1839; the 'Bibliotheca Mathematica' of Murhard, 5 vols. 8vo, Leipz. 1797-1805; the 'Bibliographie Astronomique' of La Land, 4to, Paris, 1803; the 'Bibliographical Account of the Principal Works relating to English Topography,' by Mr. Upcott, 3 vols. 8vo, 1818, one of the most accurate of this description of publications; De Morgan's 'Notices of Arithmetical Books and Authors,' 8vo, 1847; Darling's 'Cyclopædia Bibliographica, a Library Manual of Theological and General Literature, and Guide to Books,' 1857-58, a work of great value; and 'Bibliographie Biographique; ou, Dictionnaire de 26,000 Ouvrages relatifs à l'Histoire de la Vie des Hommes Célèbres,' par Edouard Marie Oettinger, Leipzig, 1850.

Another subdivision of this class of bibliographical works consists of catalogues of all such books as have been published up to a certain date posterior to the invention of printing, or of those that have appeared in some particular age, or that have issued from some particular press. Among the most remarkable of these are Maittaire's 'Annales Typographicæ ab artis inventæ origine,' 5 vols. 4to, of which the first was published in 1719 at the Hague, and the last at London in 1741 (to this should be added the supplement by Denis, 2 vols. 4to, Vienna, 1789); Panzer's 'Annales Typographicæ ab artis inventæ origine,' 11 vols. 4to, Nuremberg, 1793-1803, in which work, founded upon the preceding, the list of books is brought down to the year 1536; Ames's 'Typographical Antiquities, being an Historical Account of Printing in England from 1471 to 1600,' of which a new and enlarged edition was issued, in 4 vols. 4to, by the Rev. T. F. Dibdin in 1810-12; Maittaire's 'Historia Stephanorum,' 2 vols. 8vo, London, 1709; Maittaire's 'Historia Typographorum Aliquot Parisienium,' 2 vols. 8vo, London, 1717; and Renouard's 'Annales de l'Imprimerie des Alde,' 2 vols. 8vo, Paris, 1803.

To these works are to be added many others, which proceed upon a principle of selection. Such are the following: A. Beyer's 'Memoriæ Historico-criticæ Librorum Rariorum,' 8vo, Dresd. et Leipz. 1734; J. Vogt's 'Catalogus Historico-Criticus Librorum Rariorum,' 8vo, Hamb. 1753, and again, improved, in 1793; S. Engel's 'Bibliotheca Selectissima, seu Catalogus Librorum in omni genere scientiarum rarissimorum, cum notis bibliographicis,' 8vo, Bern. 1743; D. Clement's 'Bibliothèque Curieuse, ou Catalogue Raisonné des Livres rares et difficiles à trouver,' 9 vols. 4to, Göttingen, 1750–60. This extensive work, in which the titles of the books are arranged alphabetically, comes down only to the letter H, having been stopped at that point by the death of the author. De Bure's 'Bibliographie Instructive, ou Traité de la Connoissance des Livres rares et singuliers, contenant un Catalogue Raisonné de la plus grande partie de ces livres précieux qui ont paru successivement dans la République des Lettres, depuis l'Invention de l'Imprimerie,' 7 vols. 8vo, Paris, 1763–68. In 1769 the author published a catalogue of the library of Louis Jean Gaignat, in 2 vols. 8vo, under the title of a supplement to his 'Bibliographie;' and in 1782 a tenth volume was added to the work, being an index to the anonymous books mentioned in it, which were not included in the original index. Of the original seven volumes, the first is occupied with theology, the second with jurisprudence and the sciences and arts, the third and fourth with the belles lettres, the fifth and sixth with history, and the last with a general index to the whole, in which the books are classed according to the names of the authors. Probably no publication has contributed so much to make the study of bibliography popular as this elegant and judicious performance. Even at the present day it may be recommended as the most attractive manual of bibliographical knowledge that has yet been produced. Notwithstanding considerable deficiencies, and also some inaccuracies, the student will collect from it, more readily than from any other source, a knowledge of the titles and best editions of most, not only of the rarest but also of the most important works that had issued from the press up to the time of its appearance. It is astonishing what an extent of ground the author contrives to go over in his limited space. The articles which he describes amount to above 6000 in number; and, in regard to many of them, very ample details are given. Osmont's 'Dictionnaire Typographique, Historique, et Critique, des Livres rares, estimés, et recherchés en tous genres,' 2 vols. 8vo, Paris, 1768; J. J. Bawer's 'Bibliotheca Librorum Rariorum Universalis,' 7 vols. 8vo, 1770–91; F. X. Laire's 'Index Librorum ab Inventa Typographia ad annum 1500, cum notis,' 2 vols. 8vo, 1791; Dr. Adam Clarke's 'Bibliographical

Dictionary of the most curious and useful books, in Latin, Greek, Hebrew, Arabic, and other Eastern languages,' 6 vols. 12mo, 1803, with a Supplement, containing an account of English translations of the classics and theological writers, published under the title of the 'Bibliographical Miscellany,' in 2 vols. 12mo, in 1806; S. Santander's 'Dictionnaire Bibliographique choisi du Quinzième Siècle,' 3 vols. 8vo, 1805; Brunet's 'Manuel du Libraire, et de l'Amateur des Livres,' 2nd edit., 4 vols. 8vo, 1814, a very useful work, of which a new and enlarged edition is said (1859) to be in course of preparation by the author; Dibdin's 'Library Companion,' 2 vols. 8vo, London, 1824; Goodhugh's 'English Gentleman's Library Manual,' 8vo, 1827; Lowndes's 'Bibliographer's Manual of English Literature,' 4 vols. 8vo, London, 1834, of which a new and enlarged edition was published in 1858; Ventouillac's 'French Librarian,' 8vo, 1829; the 'Bibliotheca Historica Selecta' of B. B. G. Struvius, 8vo, 1705, and greatly augmented by C. G. Buder, 2 vols. 8vo, 1740; the catalogue of the principal historical writers appended to the Abbé Lenglet du Fresnoy's 'Méthode pour étudier l'Histoire,' 6 vols. 4to, Paris, 1729-40, or that forming the second volume of the English translation of part of the same work, by Dr. Richard Rawlinson, 2 vols. 8vo, London, 1730; Archbishop Nicolson's 'Historical Libraries of England, Scotland, and Ireland,' 4to, 1776; the 'Lettres sur la Profession d'Avocat, et Bibliothèque choisi des Livres de Droit,' of M. Camus; the catalogue of works relating to natural philosophy and the mechanical arts, annexed to the late Dr. Young's 'Lectures on Natural Philosophy;' the late Dr. Mason Good's 'Study of Medicine,' 5 vols. 8vo, 1829; A. Baillet's 'Jugemens des Savans sur les Principaux Ouvrages des Auteurs,' augmenté par M. de la Monnoye, 8 vols. 4to, Amsterdam, 1724; the 'Censura Literaria,' of Sir Egerton Brydges, 10 vols. 8vo, 1805-09; Hartshorne's 'Book Rarities in the University of Cambridge,' 8vo, London, 1829. Under this head also may be noticed the learned and admirable work of D. G. Morhof, entitled 'Polyhistor Literarius, Philosophicus, et Practicus,' first published in 1688, but the best edition of which is that of J. A. Fabricius, in 2 vols. 4to, 1747; the very erudite and elaborate 'Onomasticon Literarium' of C. G. Sax, or Saxius, published at Utrecht, in 7 vols. 8vo, from 1759 to 1790, with a supplementary volume which appeared in 1803; and 'Trésor des Livres rares et précieux,' on the same plan as that of Brunet, but containing a vast addition of information regarding works in the languages of northern and eastern Europe, Russian, Polish, Greek, &c., compiled by J. T. Grässe, of Dresden, which is being issued in parts, only four having been yet (May, 1859) published. 'The Critical Dictionary of English Literature, and British and American Authors living and deceased,' published also in 1859, is only partly bibliographical, as its 30,000 notices of authors and their works, are critical and biographical; it has forty indexes of subjects which are bibliographically useful, but it has no pretence to completeness.

There is one class of books, which, from a peculiarity by which they are distinguished, has frequently been treated by itself in bibliographical works; we mean the class of books which have not the names of their authors on the title-page. In 1690, Adrien Baillet published, not a very profound, but still a curious treatise upon books of this description, under the title of 'Auteurs Déguisés sous des noms étrangers, empruntés, supposés, feints à plaisir, abrégés, chiffrés, renversés, retournés ou changés d'une langage en une autre;' which was afterwards incorporated in the fifth volume of La Monnoye's edition of the 'Jugemens des Savans,' along with many annotations and corrections. At the end of this dissertation, which is divided into four parts, is given a list of false names assumed by authors, with their interpretation, as far as known, which extends to between sixty and seventy columns. A few years before the publication of Baillet's work, namely, in 1674, Vincent Placcius had printed a small tract in 4to. at Hamburg, entitled 'De Scriptis et Scriptoribus Anonymis atque Pseudonymis Syntagma.' In 1708 this work re-appeared under the superintendence of the indefatigable Jo. Alb. Fabricius, and of Mat. Dreyer, a lawyer of Hamburg, enlarged to 2 vols. fol. by the insertion of much new matter, and also by the addition of the following tracts upon the same subject, which had been previously printed:—'De Nominum Mutatione,' by F. Geisler, 1669, and again in 1671; 'Conjecturæ de Scriptis Adespotis, Pseudepigraphis, et Supposititiis,' by John Decker, 1678 and 1686; and 'Dissertatio Epistolica ad Placcium, qua Anonymorum et Pseudonymorum farrago exhibitur,' by Jo. Mayer, 1689. To the whole was now given the title of 'Vincentii Placcii Theatrum Anonymorum et Pseudonymorum.' To this should be added the Supplement published in 1 vol. folio, and also in 2 vols. 8vo, at Hamburg, in 1740, by Jo. Ch. Mylius, in which is comprised a reprint of the preceding Supplement, published at Jena in 1711, by Ch. Aug. Neuman, under the title of 'De Libris Anonymis et Pseudonymis Schediasma, complectens observationes generales, et Spicilegium ad Placcii Theatrum.' The original work, and the supplement of Mylius, together comprehend between nine and ten thousand articles.

But of all the works in this department of bibliography, by far the most perfect and valuable is the 'Dictionnaire des Anonymes et Pseudonymes' of the late M. Barbier, administrator of the private libraries, first of the Emperor Napoleon, and afterwards of Charles X. of France. The first two volumes of the first edition of this admirable work appeared in 1806, and were followed by two more in 1809. The publication of a second and greatly improved and enlarged edition was

commenced by the author in 1822, and completed by him in 3 vols. in 1824, about a year before his death. A supplementary volume, which he left ready for the press, has since been published by his son. The Dictionary of Barbier is confined to works in the French and Latin languages, but of these it notices between twenty-three and twenty-four thousand.

Of a somewhat different class is that of the works and editions of a particular author. Of this class, a favourable specimen is the 'Alphabetical Catalogue of an extensive Collection of the writings of Daniel De Foe, and of the different publications for and against that remarkable writer,' published in 1830, which was compiled by Thomas Rodd. Of private collections the 'Bibliotheca Spenceriana,' an account of the library at Althorp, by Dr. Dibdin, is perhaps unequalled in the style of its getting up, and contains much curious and interesting matter connected with that large and valuable library.

For further information upon the different branches of bibliography the reader may refer to the Rev. T. H. Horne's 'Introduction to the Study of Bibliography,' 2 vols. 8vo, Lond. 1814; C. F. Achard's 'Cours de Bibliographie,' 3 vols. 8vo, Marseilles, 1807; 'Handbuch der Deutschen Literatur, seit der mitte des achtzehnten Jahrhundert bis auf die neueste Zeit systematische bearbeitet, und mit den nöthigen Registern versehen: Neue, mit verscheidenen Mitarbeitern besorgte Ausgabe,' 4 vols. 8vo, Leipzig, 1822-27. See also J. M. Quérard, 'La France Littéraire: ou Dictionnaire Bibliographique des savants, historiens, et gens-de-lettres, de la France; ainsi que des littérateurs étrangers qui ont écrit en Français, plus particulièrement pendant les 18ième et 19ème siècles,' 10 vols. 8vo, Paris, 1827-42: O. Rich, 'Bibliotheca Americana Nova: or a Catalogue of Books in various languages relating to America, printed since the year 1700; compiled principally from the books themselves,' 8vo, Lond. 1835. Among works of this class might also be mentioned such as P. J. Safarik's 'Geschichte der slawischen Sprache und Literatur nach allen Mundarten,' Buda, 1826, which is a great storehouse of information on Slavonic literature, rather of a bibliographical than historical character; its principal feature being its very full lists of titles of books.

BIBROMANILINE, *Dibromaniline.* [ANILINE.]

BIBROMANTHIC ACID. [EUXANTHIC ACID.]

BIBROMISATIC ACID. [INDIGO.]

BIBROMOQUINONIC ACID. [QUINONIC ACID.]

BIBROMOSALICYLIC ACID. [SALICYLIC ACID.]

BICHLORHYDRIN. [GLYCERIN.]

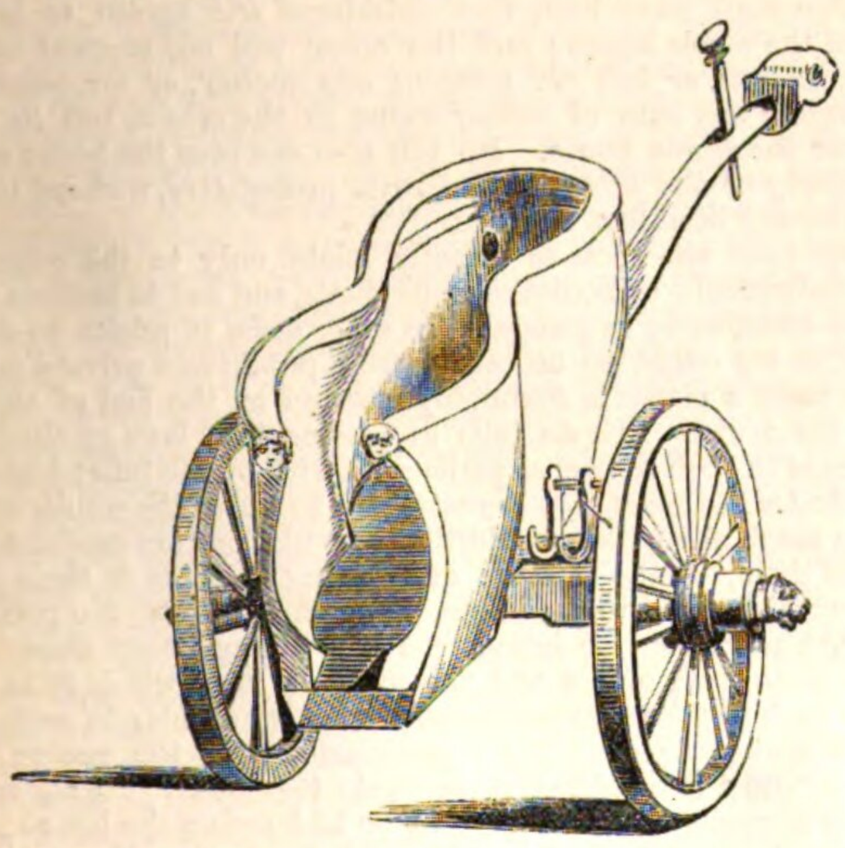
BICHLOROXALIC ACID ($C_8Cl_4O_6,2HO$). This acid, which has never been obtained in a separate state, is one of the products of the action of chlorine upon citric acid. The potash and silver salts only have been examined.

BIDPAI, Pancha Tantra, or Fables of. [PILPAY, in BIOG. DIV.]

BIELA'S COMET. [COMETARY BODIES.]

BIENNIALS are plants which require two seasons of growth to produce their flowers and fruit; they differ from annuals in nothing but this circumstance, perishing as soon as their seeds are ripened.

BIGA, a chariot or car drawn by two horses: called by Suetonius ('Calig.' c. 19.) *Bijuge curriculum.* The biga was the most common chariot in use among the Romans. They had also their trigæ, quadrigæ, and sometimes their sejuges septim-juges, &c., and Suetonius assures us that Nero, when he was a performer in the Olympic games, made use of a decem-jugis, a chariot drawn by ten horses coupled together. (Suet. in Ner. c. 24.)



Pliny attributes the invention of the biga to the Phrygians. ('Hist. Nat.' lib. vii. c. 56.) Isidorus says the inventor was Ciristines the Sicyonian. ('Origines,' lib. xvii. c. 35.)

The Roman silver coins stamped with a form of a chariot drawn by two or four horses were called *bigati,* and *quadrigati.* (See Pliny, 'Hist. Nat.' lib. xxi. c. 3.) Hence Livy (lib. xxxiii. c. 23.) uses the term *argentum bigatum.* The bigati, quadrigati, and victoriati, were all of equal value, and differed only in the impress from which they derived their several names. The biga was an emblem of victory.

BIGAMY, in the canon law, signified either a second marriage after the death of the first wife, or a marriage with a widow. It incapacitated men for holy orders; and until the stat. 1 Edw. VI. c. 12, s. 16, it was a good counterplea to the claim of benefit of clergy. (Woodesson's 'Vinerian Lectures,' i. 425.)

Bigamy, by the English law, consists in contracting a second marriage during the life of a former husband or wife, and the statute 1 James I. c. 11. enacts that the person so offending shall suffer death, as in cases of felony. This statute has been repealed by 9 Geo. IV. c. 31, s. 22, which makes any person who being married shall marry any other person during the life of the former husband or wife, whether the second marriage shall have taken place in England or elsewhere, and any person aiding, guilty of felony, and punishable by transportation for seven years (for which penal servitude has since been substituted), or imprisonment (with or without hard labour) for a term not exceeding two years. The statute excepts, first, any second marriage contracted out of England by any other than a subject of his Majesty; second, any person whose husband or wife shall have been continually absent during seven years, and shall not have been known by such person to have been living within that time; third, a person divorced from the bond of the first marriage; fourth, one whose former marriage shall have been declared void by the sentence of a court of competent jurisdiction.

With respect to the *third* exception it has been determined in a case where a Scotch divorce *a vinculo* was pleaded, that no sentence of any foreign court can dissolve an English marriage *a vinculo* unless for grounds on which it was liable to be so dissolved in England; and that the term "divorced" applies to the sentence of a spiritual court within the limits to which the statute extends. The *fourth* exception cannot be taken advantage of, if the first marriage has been declared void only collaterally and not directly; or if it can be shown to have been obtained fraudulently or collusively.

BILIFULVIN. A yellow colouring matter found by Berzelius in the bile. Its composition is unknown, but it appears to be the lime or soda salt of a peculiar acid.

BILIN. [CHOLIC ACID.]

BILIPHEIN ($C_{32}H_{18}N_2O_9$?). A brown colouring matter found in the bile, and in the intestinal canal. It is to this substance that the solid excrements owe their colour. As an abnormal constituent, it is also met with in the blood; and the yellow tint of the skin and of the cornea in jaundice is likewise due to this substance. Biliary calculi are often almost entirely composed of this body, and constitute the best source of biliphein, which may be prepared pure by washing the powdered calculi successively with ether, alcohol, boiling water, hydrochloric acid, and cold water; finally dissolving the residue in a weak solution of carbonate of soda, and then re-precipitating with an acid. Whilst the biliphein is in solution, it is necessary to preserve it carefully from the air, otherwise it oxidises and is converted into *biliverdin.* The solution must therefore be operated upon in an atmosphere of hydrogen gas.

Biliphein is a brown, amorphous, infusible solid, insoluble in boiling water, but soluble in boiling alcohol. The alcoholic solution gradually absorbs oxygen from the air, and becomes green. It dissolves slightly in hydrochloric acid, with a blue colour. If red nitric acid be added in excess to a dilute alkaline solution of biliphein, the liquid becomes at first green, and subsequently passes through various shades of blue, violet, and red, until it finally becomes yellow.

BILIVERDIN ($C_{16}H_9NO_5$?). A green colouring matter found in ox-gall, and also produced by the oxidation of biliphein. It is insoluble in water, but dissolves in alcohol with a green colour. [BILIPHEIN.]

BILL CHAMBER, a department of the Court of Session in Scotland, in which one of the judges officiates at all times during session and vacation. The youngest judge is lord ordinary on the bills during session; the duty is performed by the other judges, with the exception of the two presidents, by weekly rotation during vacation. All proceedings for summary remedies, or for protection against impending proceedings, commence in the Bill Chamber—such as interdicts (or injunctions against threatened injuries, or against courts exceeding their jurisdiction, as in the case of the church courts attempting to take cognisance of civil questions), or suspension of execution. The process of sequestration [BANKRUPT LAWS OF SCOTLAND] issues from this department of the court. By far the greater number of the proceedings are sanctioned by the judge as a matter of form, on the clerks finding that the papers presented ask the usual powers in the usual manner; but where a question of law is involved in the application, it comes into the Court of Session, and is discussed as an ordinary action. The Lord Ordinary on the Bills, as he is termed, is the representative of the court during vacation.

BILL IN CHANCERY. [EQUITY.]

BILL IN EQUITY. [PLEADING IN EQUITY.]

BILL IN PARLIAMENT, is the name given to any proposition introduced into either house for the purpose of being passed into a law, after which it is called an act of parliament, or statute of the realm. [STATUTE.]

In modern times a bill does not differ in form from an act, except that when first brought in, it often presents blanks for dates, sums of money, &c., which are filled up in its passage through the house. When printed, also, which (with the exception only of naturalisation and name-bills, which are not printed) it is always ordered to be, either immediately after it has been read a first time, or at some other early stage of its progress, a portion of it, which may admit of being disjoined from the rest, is sometimes distinguished by a different type. But most bills are several times printed in their passage through the two houses. A bill, like an act, has its title and its preamble, usually setting forth the reasons upon which it professes to be founded, and concluding "Be it therefore enacted by the Queen's most excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same as follows;" after which come the enacting clauses in their order. The advantage of this is that a bill becomes a law at once on receiving the royal assent.

Originally, the bills passed by the two houses were introduced in the form of petitions, and retained that form when they came to receive the royal assent. The whole of those passed in one session were then, after the parliament rose, submitted to the judges, to be by them put into the proper shape of a law. But it was found that in undergoing this process the acts, as passed by the parliament, were frequently both added to and mutilated. Indeed a great deal of the power of making the law was thus left in the hands of the judges, and of the royal authority, in so far as these learned personages might be under its influence. To remedy this evil it was arranged in the reign of Henry V., that the statute roll of the session should always be drawn up before the parliament rose. In the following reign, that of Henry VI., the bill came as now to be prepared in the form of an act.

Bills are either public or private. In the introduction of a public bill the first motion made in the House of Lords is that the bill be brought in; but in the House of Commons the member who purposes to introduce the bill must first move that leave be given to bring it in. If that motion is carried, the bill is then either ordered to be brought in by certain members, generally not more than two, of whom the mover is one. A select committee is sometimes appointed for that purpose. When the bill is ready, which it frequently is as soon as the motion for leave to bring it in has been agreed to, it is presented at the bar by one of those members, and afterwards, upon an intimation from the speaker, brought up by him to the table. The next motion is that it be read a first time; and this motion is most frequently made immediately after the bill has been brought up. This being carried, a day is appointed for considering the question that the bill be read a second time. The second reading being carried, it is next moved that the bill be committed, that is, that it be considered clause by clause either in a committee of the whole house, or, if the matter be of less importance, in a select committee appointed for the purpose. When the committee have finished their labours they make their report through their chairman; and the next motion is that the report be received. Besides modifying the original clauses of the bill, it is in the power of the committee, if they think proper, both to omit certain clauses, and to add others. Sometimes a bill is ordered to be recommitted, that it may undergo further consideration, or that additional alterations may be made in it. The report of the committee having been received, the next motion is that the bill be read a third time, and when that is carried, there is still a further motion, that the bill do pass. When a bill has passed the House of Lords, it is sent down to the House of Commons, usually (since the abolition of the office of master of chancery,) by the clerk assistant, or reading clerk, sometimes by the Queen's Sergeant, and occasionally, in the case of measures of great importance, by one or more of the judges, who make three obeisances as they advance to the speaker, and, after one of them has read the title of the bill, deliver it to him, desiring that it may be taken into consideration, When a bill, on the other hand, is sent up from the Commons to the Lords, it is sent by several members (the speaker being frequently one), who, having knocked at the door of the Lords' house, are introduced by the usher of the black rod, and then advance to the bar, making three obeisances. The speaker of the house, who is usually the lord chancellor, then comes down to the bar, and receives the bill, the member who delivers it to him stating its title, and informing him that it is a bill which the Commons have passed, and to which they desire the concurrence of their lordships. A bill thus received by the one house from the other is almost always read at least a first time; but it does not appear to be a matter of course that it should be so read. It then goes again through the same stages as in the other house.

The bill may be debated on any one of the motions which we have mentioned, and it commonly is so debated more than once. It is usual, however, to take the debate upon the principle of the proposed measure either on the motion for leave to bring in the bill, or on that for the second reading; the details are generally discussed in the committee. Amendments upon the bill, going either to its entire rejection, or to its alteration to any extent, may be proposed on any occasion on which it is debated after it has been brought in. Before it is committed also certain instructions to the committee may be moved, upon which the committee must act.

Bills were formerly engrossed after the report of the committee, on

rolls of parchment, and in the same shape sent to the other house, and after the royal assent enrolled as statutes; clauses added being engrossed on separate sheets, and attached to the bill as *riders*. This system was discontinued in 1849, and printing substituted.

Bills of all kinds may originate in either house, except what are called money bills, that is, bills for raising money by any species of taxation, which must always be brought first into the House of Commons. The Commons also will reject any amendment made upon a money bill by the Lords. The Lords again have a standing order against proceeding with any bill for restitution in blood which shall not have originated in their own House.

When a bill has passed the Commons and is to be sent up to the Lords, the clerk writes upon it *Soit baillé aux Seigneurs;* and upon one which has passed the Lords and is to be sent down to the Commons, the clerk of the Lords writes *Soit baillé aux Communs.* If it is afterwards passed by the Commons, the clerk writes upon it *Les Communs ont assentez.* All bills of supply, after being passed by the Lords, are returned to the House of Commons, in which they had originated, and there remain till they are brought to the House of Lords by the speaker to receive the royal assent: all other bills are deposited with the Lords till the royal assent is given to them.

A bill, after it has been introduced, may be lost either by the royal assent being refused (of which, however, there is no instance in recent times), or by a motion for its rejection being carried in any of its stages in its passage through either house, or by any of the motions necessary to advance it on its progress being dropped or withdrawn. The rejection of the bill may be effected by the motion in its favour being simply negatived, or by a counter-motion being carried to the effect that the next reading be deferred till a day by which it is known that parliament will have been prorogued (generally till that day six months, or that day three months), or by the carrying of an amendment entirely opposed to the measure. The motion for carrying it forward on any of its stages may be dropped either by the House not assembling on the day for which the order made respecting that motion stands, or simply by no member appearing to make the motion. When a motion has once been made, it can only be withdrawn by consent of the House.

If a bill has been lost in any of these ways, the rule is that the same measure cannot be again brought forward the same session. "It however appears," says Mr. Hatsell, in treating of this subject in his 'Precedents,' "from several of the cases under this title, as well as from every day's practice, that this rule is not to be so strictly and verbally observed as to stop the proceedings of the house: it is rather to be kept in substance than in words; and the good sense of the House must decide, upon every question, how far it comes within the meaning of the rule." In fact there are several remarkable examples of the regulation being entirely disregarded. And sometimes a short prorogation has been made merely to allow a bill which had been defeated to be again introduced.

When a bill which has passed one house has been amended in the other, it must be returned, with the amendments, to be again considered in the house from which it had come; and it cannot be submitted for the royal assent until the amendments have been agreed to by that house. In case of a difference of opinion between the two houses, the subject is frequently ordered to be discussed in a conference. [AMENDMENT.]

According to the standing orders of the House of Commons, no bill relating to religion, or trade, can be brought into the House until the proposition shall have been first considered and agreed to in a committee of the whole house; and the house will not proceed upon any petition, motion, or bill for granting any money, or for releasing or compounding any sum of money owing to the crown, but in a committee of the whole house. No bill also can pass the house affecting the property of the crown or the royal prerogative, without the royal consent having been first signified.

Private bills are such as directly relate only to the concerns of private individuals, or bodies of individuals, and not to matters of state or to the community in general. In some cases it might be doubtful whether an act ought to be considered a public or a private one; and in these cases a clause is commonly inserted at the end of the act to remove the doubt. Private bills in passing into laws go through the same stages in both houses of parliament with public bills; but relating as they do for the most part to matters as to which the public attention is not so much alive, various additional regulations are established with regard to them, for the purpose of securing to them in their progress the observation of all whose interests they may affect. No private bill, in the first place, can be introduced into either house except upon a petition stating its object and the grounds upon which it is sought. Nor can such petitions be presented after a certain day in each session, which is always fixed at the commencement of the session, and is usually within a fortnight or three weeks thereafter. In all cases the necessary documents and plans must be laid before the house before it will proceed in the matter, and it must also have evidence that sufficient notice in every respect has been given to all parties interested in the measure. To a certain extent the consent of these parties is required before the bill can be passed. For the numerous rules, however, by which these objects are sought to be secured, we must refer to the Standing Orders themselves, which prescribe most minutely the

principal steps necessary to be taken in the case of all descriptions of private bills, which are principally for enabling associations of individuals to undertake the formation of railways, roads, canals, docks, and other such works.

An important respect in which the passage through parliament of a private bill differs from that of a public bill is the much higher amount of fees paid in the case of the former to the clerks and other officers of the two houses. Although the high amount of the fees payable on private bills has been the subject of much complaint, and is undoubtedly, in some cases, a very heavy tax, it is to be remembered that the necessary expense of carrying the generality of such bills through parliament must always be very considerable, so long as the present securities against precipitate and unfair legislation shall be insisted on. The expenses of agency, of bringing up witnesses, and the other expenses attending the making application to parliament for a private bill, at present often amount to many times as much as the fees. These fees, on the other hand, are considered to be some check upon unnecessary applications for private bills, with which it is contended that parliament would otherwise be inundated. The misfortune is, that it is not the most unnecessary applications which such a check really tends to prevent, but only the applications of parties who are poor, which may be just as proper to be attended to as those of the rich.

A useful little manual on 'Private Bill Legislation, comprising the steps required to be taken by Promoters or Opponents of a Private Bill,' has been prepared by J. B. Bristowe, Esq., Barrister-at-Law, and was published early in 1859.

BILL OF EXCHANGE, a well-known mercantile instrument, of great and extensive usefulness, which may be described as a written order or request addressed by one person to another, directing the latter to pay on account of the former to some third person or his order, or to the order of the person addressing the request, a certain sum of money at a time therein specified. In commercial language, the person giving this direction is called the drawer of the bill;—he to whom it is addressed the drawee, or, if he accepts it, the acceptor;—he in whose favour it is given the payee: if the payee indorses it, he is called an indorser, and the person to whom it is indorsed, the indorsee, who may in turn likewise become an indorser. Bills of Exchange are in this country classified as foreign or inland bills. This distinction is more than nominal, for it carries with it legal consequences of importance, and depends upon the following circumstances. If the drawer or drawee, or, if both the drawer and drawee of a bill, are resident in a foreign country, it is a foreign bill; but it is an inland bill, if it is both drawn and made payable—or if drawer and drawee are both—within the territory of the United Kingdom of Great Britain and Ireland, the islands of Man, Guernsey, Jersey, Alderney and Sark, and the islands adjacent to any of them, being part of the dominions of her Majesty. Thus, a bill drawn by a person in France upon a person in England, or conversely, by one in England upon another in France, is a foreign bill: but a bill which is drawn in London upon Edinburgh, or in Dublin, or Douglas, of the Isle of Man, upon London, is not a foreign, but an inland bill.

At what time and by what people bills of exchange were first brought *into* use, is a matter of history which has not been satisfactorily ascertained. The invention has been variously assigned—to the Jews and Lombards, as a mode of secretly withdrawing their effects from France and England, when, in the 13th century, they were banished for usury—to the Florentines flying from the successful faction of the Ghibellines—and to the Mongolian conquerors of China. These, however, one and all, are conjectures resting on no solid foundation. All that can be safely affirmed is, that instruments of this kind were current among the commercial states of Italy in the early part of the 14th century, and that they were not unknown about the middle of the same century in England. It has been commonly stated that the use of foreign bills preceded that of inland, and the statement, when confined to England, into which the practice was imported from other countries, is unquestionably true; but there seems no fact or reason to lead to the supposition that the original application of the invention was restricted to such uses. The object to be attained was the facilitation of exchange between parties resident at a distance from each other, by dispensing with the remittance of money in specie; and whether the parties were resident in different countries or in the same, the inconvenience would equally exist, and the remedy be equally applicable.

The history of bills of exchange would furnish much curious and instructive matter, as illustrative of the progress of trade, from the simple and somewhat clumsy operations of early times down to the refined and complicated system of modern exchanges. Originally, as has been said, they were employed solely as the means of remittance, and the exigency which brought them into use may be explained as follows:—A., at Hamburg, consigned goods to B., in London, either in execution of an order, or as his factor for sale. B., thereupon, being debtor to A. for the invoice amount, or the proceeds of the sale, as the case might be, was desirous of remitting to A. accordingly. The remittance could only be made in money or in goods; but A. might not want a return cargo of English commodities, and the sending out of specie was both inconvenient and hazardous. For, first, the proper coin was to be procured at the money-changers; next, a ship was to be found to carry it; then it was to be safely deposited on board; an

insurance, if so happy a contrivance had existed, was to be effected; and advices sent out by another vessel to A. If the ship arrived safe, there was the unloading, the carriage, and delivery on the other side; if it were wrecked or captured, there was the entire loss, when uninsured, and in case it had been insured, the trouble, still, of procuring payment. Now suppose (to take the simplest case) that some third person, C., were about to take his departure from Hamburg to London, mutual convenience would suggest the following arrangement:—A. would deliver to C. an open letter addressed to B., requesting him to pay to C. the amount intended to be remitted; and C., on receiving the letter into his possession, would pay directly to A. the value of it in money current at Hamburg, and having carried it over to London would there receive from B. the sum specified. By this simple contrivance much of the expense, and all the risk and trouble of remittance would be saved to B. or A.; and C., besides having a more convenient and portable sign of wealth, would probably receive a *bonus*, that is, some advantage for the accommodation. It is obvious, however, that to bring the machinery into operation several things would be wanting: such as, first, knowledge by both parties of the mutual want; secondly, confidence on the side of C. that the money would be paid by B. on presentment of the letter of request, or that in default of payment by B. he might safely look for reimbursement to A.; and, thirdly, the assessment of the present value of the letter, or, in other words, the determining how much C. ought to give A. in ready money of Hamburg for the sum specified in the letter, to be paid at a future day in money of England. Now one branch of this last requisite, the adjustment of the comparative value of different currencies, fell directly within the province of the money-dealers, who, from their stalls or *banques* at the great fairs and marts of exchange, received the name of *banquiers* (bankers), and as all persons about to remit or to proceed to foreign countries resorted to them for the requisite coin, they would be enabled to furnish the merchants with information as to the other particulars also, and would thus naturally become the negotiators of this sort of exchanges.

But the transactions by way of letters of exchange would have been very limited, had they depended on the occasional coincidence of a party setting out in person to the country to or from which the remittance was to be made. There were, however, other cases in which the like operation might be made available; for although A. might not want goods from England in return for those shipped by him from Hamburg, other Hamburg merchants might, and it might thus happen that, at the very time of the intended remittance, B. had money owing to him at Hamburg in respect of goods so shipped. Let it be supposed then that C., instead of setting out in person to London, were about to remit money to B., it is obvious that in that case the whole or a portion, as well of B.'s debt to A., as of C.'s debt to B., might be extinguished by a simple arrangement of the same kind as that before described. B. would write a letter addressed to C., requesting him to pay a specified sum to A., or, in mercantile phrase, would draw upon C. in favour of A.; this letter or draft he would remit, as payment, to A., who upon presentment to C. would receive from him the amount, and would give credit to B. in account accordingly.

To advance a step further, B. might not at the moment have any debtor at Hamburg through whom the substitution could be made; but as the trade between two countries is never, unless under unnatural circumstances, entirely unilateral—consisting, that is to say, solely of shipments of goods on the one part, and solely of remittances of money on the other—it would happen that if B. had not, other London merchants would have, sums of money owing from Hamburg. When therefore the convenience of this method of exchanges had been felt, it was natural that B., when desirous of remitting, should endeavour to find out some person so circumstanced, from whom he might procure an order upon his debtor; in other words, that he should buy a bill on Hamburg for remittance to A. For the reasons before mentioned, recourse would be had for this purpose to the money-dealers; and it is not difficult to conceive by what steps the business of procuring and supplying bills soon became in their hands a distinct and important branch of trade.

Nor, indeed, without the intervention of such dealers, could the system ever have become extensively useful; because although it is true, as has been said, that in the commercial intercourse of two countries it seldom happens that either is merely buyer or merely seller, it is equally rare that the value of the commodities exchanged is exactly balanced. There would consequently be at times a scarcity of bills upon one country and an excess of those upon some other. But as the system gradually matured itself, the dealers through whom the exchanges were effected would find their advantage in adjusting the demand and supply by sending or procuring the superfluous bills in one market to fill up the void in another; and would thus be enabled, in general, to furnish the required accommodation on payment of a proportionate premium.

In the meantime, the instrument of transfer, which in this country had received the name of a bill of exchange, assumed a concise and permanent form, and became clothed with such properties and incidents as experience showed to be necessary or convenient. At first, no doubt, the order was to pay on presentment to the drawee, or as it was expressed in the instrument, "on sight." But, as the intervals between drawing and presentment would necessarily be extremely variable, it

was found expedient, or it insensibly became the practice, to fix them by a definite scale; and hence probably arose what was called the *usance* between two ports or countries, being, as the name would seem to import, the period fixed by usage, at which, with reference to the date, a bill was presentable for payment. Afterwards these usances came to signify the periods at which the merchants of any particular country or port were in the practice of paying the bills so drawn upon them, and these customary periods being of course universally known among commercial men, the word usance soon came to signify a specific term of days, and it was formerly therefore not uncommon, when by agreement the time of payment was determined, to draw foreign bills payable at one, two, or more usances. In modern times, the more frequent practice has been to make them payable at so many days after sight, or at so many months or days after date. Again, in times when money was less at command than at present, it was but reasonable, that even after the maturity of the bill a short space should be allowed to the drawee for providing the requisite cash; and hence it became usual to grant what we term *days of grace*, which, though varying as to limits in different communities, are yet binding within the limits recognised in each community as of the law and custom of merchants.

Originally, as we have supposed, the bill was a letter addressed by B. to C., directing him to pay A. But an obvious improvement would early suggest itself, namely, that as it might not be convenient to A. to present the letter in person, he should have authority given him to appoint another, by whom the presentment might be made and the money received in his stead. It assumed therefore the form of a direction to pay A., or such person as A. should nominate and appoint, expressed with the quaint conciseness of mercantile phraseology, thus: "Pay A., *or order*." But if the letter or bill in the hands of A. were assignable, there was no reason why it should not be equally so in the hands of his assignee, and thus by the operation of the words "or order," it obtained the character of a negotiable instrument or sign of value, transferable from hand to hand by a simple act of delegation apparent upon some part of it. So essential to bills, and almost innate to the invention of them, does this quality now appear to be, that it excites no wonder to find it recognised by the law of some countries, such as Scotland, as a property inherent in the instrument and independent of words of transfer. In the majority of commercial countries, however, it is otherwise. In them a sagacious wisdom, or a happy accident, by making the transferability of bills dependent on the use of words of transfer, has thus enriched the world with a variety of instruments adapted to the purposes of society. A bill without words of transfer is in England not transferable, and is payable only to the payee named; one containing the words "or order," is transferable by written assignment only; whereas a bill payable to "bearer," or to "A. or bearer," is transferable from hand to hand by delivery merely. The words "or order," were no doubt the earlier form of this addition. In the case of such an instrument, the form of assignment, it may be readily conceived, would at first run in some such language as this: "Pay the within to D., or his order—signed A.," and by a similar superscription D. might in like manner assign his right to E., and E. to F., and so on. But as the bill was of course *delivered* to each successive assignee, possession was of itself a sufficient voucher for payment, and the special superscription therefore being frequently dispensed with as unnecessary, the assignment of the prior holder came to be indicated by his signature alone, but with a difference of legal effect in each of these forms of assignment. For a bill under the full form is not afterwards transferable except by the written assignment of the person named; whereas the other form has the same effect of making the bill assignable by delivery without writing, as though the word "bearer" appeared in the body of the instrument. The practice of writing the assignment on the back of the instrument has given it the name of *indorsement;* and the form first described, in which the assignee is named, is termed a *special* indorsement, or an indorsement *in full;* and the mere signature of the assignee an indorsement *in blank*.

When bills were drawn payable, not as at first, on sight, but at some future day, it was natural that the first holder who had the opportunity of doing so should, during the currency of the specified period, show the bill to the drawee, and procure from him an undertaking to pay it at maturity. If he refused, the bill was protested for non-acceptance, and notice of the dishonour was immediately communicated to the drawer. If he gave the undertaking either verbally or in writing upon the bill or otherwise, he was said to have *accepted* it, and he became thenceforth liable, as the acceptor, for the amount specified; for, by the acceptance, the drawee had affirmed the right of the drawer to call upon him for payment of the money at the time specified, and he had assented to the transfer of that right, in accordance with the tenor of the instrument presented to him. If, therefore, after acceptance, he refused to pay the bill when due, he was responsible to the drawer, both in respect of his original debt and his express engagement on the instrument, and to the other parties to the bill on the contract which it contains. Such is the obligation assumed by the acceptor; but the right of the holder takes a more extensive range. For although, after acceptance, the drawee became the principal debtor, to whom therefore recourse must be had in the first instance; yet, if upon regular presentment he made default in payment, the holder was not restricted to his remedy against him alone, but might resort to all prior parties whose names appeared upon the instrument. For as the indorsement,

like the original drawing, conferred the right to receive the money, it was to be presumed that neither had been made without an equivalent, and it was but justice, therefore, that on the dishonour of the bill by the drawee, the holder should receive back the value which he had given; and as every person whose signature, whether as drawer or indorser, appeared upon the bill acknowledged himself by the act of signing to have received value for the delivery of the order, it was not unreasonable that the reimbursement should be claimed, not merely from the party from whose hands the bill had been received, but also from the drawer and every subsequent party whose name preceded that of the holder. The result therefore was this: if the drawee paid according to the tenor of the bill, the arrangement was complete, and all parties were satisfied; but if he dishonoured it, by a refusal either to pay or to accept on due presentment, a notification of the dishonour was conveyed by the holder to all parties preceding him, or to such as he thought fit to call upon for indemnity; if then the drawer paid the money, or, as it was termed, *took up the bill*, all the other parties were exonerated, and the drawer had his remedy against the drawee, upon the bill if accepted, or upon the original consideration in respect of which it was drawn, if the acceptance had been refused. In like manner, whoever satisfied the bill by payment, thereby discharged all parties posterior to himself, and obtained a right against all who preceded him. Thus each successive indorsee had the accumulated security of all the parties whose signatures were upon the instrument as acceptor, drawer, or indorser, when it came into his hands.

As bills remitted to or from places abroad are liable to be lost in their passage, it became usual, in order to obviate the inconvenience thence resulting, to draw them *in sets;* that is to say, two or more parts of each bill were drawn, and described as the first, second, third, and so on, each containing a condition that it should be payable only while the others remained unpaid. This practice of drawing in sets is made available for another purpose. The payee having indorsed and paid away one part, frequently remits another part to some agent or correspondent at the place of the drawee's residence, to be by him presented for acceptance, with a direction added, by way of memorandum, to the bill, that, when accepted, it is to be held for the use of the person who shall duly present the other part or parts for payment at maturity. The advantage of this arrangement is obvious: if the bill be accepted, it is held, according to the direction, till maturity; if refused, it is protested, and notice is given to the drawer. Upon this protest the drawer may be called upon to give security for the due payment of the bill at the expiration of its currency; or, as occasionally happens, some correspondent of the drawer at the place upon which the bill is drawn accepts it for his honour, and thereby places himself in the situation of the original drawee, being liable as acceptor to all parties subsequent to the drawer. Such an acceptance is called an acceptance *supra protest*, or *for honour*, and may be made at any time during the currency of the bill, and on behalf of any party who is liable upon it after default made by the drawee. In short, without entering into further details, by successive modifications and improvements the letter of request has become at length a very useful and convenient instrument of exchange, the operation of which as a vehicle of remittance at the present day will be apparent from the following illustration.

A person in London has a payment to make in Paris, say, for convenience, of 1000*l*. Instead of remitting the money, he goes to an exchange-broker, and purchases from him a bill on Paris equivalent to that sum. But how is that equivalent to be ascertained? or, in other words, for what amount in French money is the bill to be drawn? In the determination of this question there are several items of calculation. The bill will be payable in France; how many francs then are equal to 1000*l*. By the mint regulations between England and France, 1*l*. sterling of English money is equal to 25 francs 20 cents, which is therefore the nominal or standard *par* of exchange between the two countries. According to this scale, then, 1000*l*. in London would be worth 25,200 francs in Paris. But the par is fixed on the supposition that the currencies of the two countries respectively are uniformly of the weight and purity established by the Mint; whereas, not unfrequently, the coin is debased by alloy or attrition, and the relative value undergoes a corresponding alteration. This deviation however is well known, and may be regarded as comparatively constant. But there are other circumstances affecting the ratio of value of a more fluctuating and unsteady operation. When, for instance, any considerable portion of the circulating medium of either of the two countries between which the exchange is to be effected consists of a paper currency, the standard is materially affected by the quantity of paper in circulation. Without entering into an exposition of the law of this variation, it is sufficient to remark, that a redundancy of paper money has invariably the effect of depreciating the standard, or, in other words, of raising the value of the *standard coin* as compared with the same nominal sum in *paper money*. This effect is temporary only when the paper is convertible into specie on demand; if inconvertible, it is both permanent and considerable. Thus it is well known that, at one period during the war which followed the first French Revolution, the English guinea was worth 26*s*. in money, estimated according to the value of the 1*l*. sterling in bank notes. At that time therefore the English pound would fall far below the Mint standard of 3*l*. 17*s*. 10½*d*. per ounce, and a proportionate effect would be produced on the rate of exchange with any

other country in which the standard was maintained. Taking, as before, the instance of France, the par would vary, other things remaining constant, from 25 francs to somewhere about 19 francs, or 1000*l.* in a Bank of England note would buy a bill on Paris, not for 25,200 francs, but for about 19,000 francs only. But it is evident that the same cause might be operating in a greater or less degree in France also, in which case the calculation would be still further complicated by a *comparison* of the depreciation in the one country with that in the other. The variation here taken for an example is of course an extreme case, but fluctuations the same in kind, though less in degree, are still of continual occurrence, and must be carefully taken into account in all calculations as to the price of bills.

But besides these monetary influences on the nominal par, there are other causes in operation which materially affect the rate of exchange, and by consequence the price of bills. The accommodation of a remittance in the form of a bill of exchange is worth a calculable sum, the maximum being the compound of the labour, expense, and risk of the transmission of money in specie. Suppose this maximum to be one per cent, it is evident that it is worth the while of the remitter to pay any sum short of 10*l.* for the purchase of a bill equivalent to 1000*l.* Now the market price of bills, like that of every other commodity, is mainly dependent on the relation of the supply to the demand, and this again is primarily regulated by the state of trade between two given countries. When the value of the exports to any country in a given period is equal to the value of the imports from the same country in the same period, the trade is said to be balanced; the bills drawn in each country upon the other will be equal in amount, and this equilibrium constitutes what is called the *real* par of exchange. But it is obvious that this state of things can never actually exist, that it is the point on each side of which the exchanges will continually oscillate, and at which they will never rest. Even where, upon the average of years or months, the trade is nearly even, there will be disturbing circumstances which will have a temporary effect upon the exchanges. There will consequently be occasional scarcity and occasional abundance of foreign bills in the market. When scarce, their price of course is higher, or, as it is ordinarily expressed, they bear a *premium*. At such times the imports exceed the exports, and the exchanges are said to be *against us*. Suppose that, in the trade between England and France, the value of our imports from France exceeds that of our exports to France by about three-fourths. The effect of this, if matters were left to themselves, would be, that of the remittances to France three-fourths must be made in specie, and that the bills in which the remaining one-fourth was made would be at the maximum price; that is to say, taking the scale before adopted, would bear a premium of all but one per cent. But it is a fact, incontestably established, that in every trading community the value of the whole of the exports taken together is, upon an average, very nearly balanced by the value of the whole of the imports, or, in other words, that ultimately all commodities imported are paid for directly or indirectly in commodities exported. Necessarily, therefore, the bills drawn in England upon foreign countries, say in one year, nearly balance the bills drawn in foreign countries upon England in the same period. Thus, to take a familiar instance, although there may be a deficiency in London, to the extent of three-fourths, of bills upon France, there may be an excess, in nearly the same ratio, of bills upon Belgium, and in like manner there may be an excess in Belgium, to the same extent, of bills upon France. Acting on the knowledge of this fact, the London bill-merchant, by means of his agent, will buy bills upon Paris at Antwerp, where they are cheapest, and bring them for sale to London, where they are dearest. The cost of procuring, and the profit of the bill-merchant, therefore, upon this transaction, constitute the third element in the calculation. Supposing then the bill to be a *good* one,—that is to say, guaranteed by names of known and established credit, the only remaining operation is to estimate the discount according to mercantile practice, or, in other words, the interest of 1000*l.* in money for the time which will elapse before payment of the bill; and the combined result will give the sum in francs for which the bill is to be drawn, or the amount of bills already drawn to be given in exchange for 1000*l.*

The same remarks, *mutatis mutandis*, are applicable, if instead of a remittance to Paris a sum of money was to be received from thence; for the mode adopted would be this. The party in London would draw a bill upon his debtor in Paris, for which the exchange-broker would immediately give him the value, ascertained as before, either in cash or in bills upon London, or in both; and although the system, as here explained in detail, may seem, as in truth it is, of some complexity, yet practically the price, like that of every other commodity, readily adjusts itself. In London it is the practice for the bill-brokers to go round to the principal merchants and inquire whether they are buyers or sellers of bills. The relation of supply and demand being thus ascertained, a few of the most influential merchants settle the average price at the Royal Exchange; and a document known as 'Wetenhall's List' contains the record of rates according to actual transactions. By these means the value of particular bills, varying of course according to the credit of the parties to them, or, as it is generally called, *the goodness of the names*, is easily determined.

Bills of exchange are also in frequent use for the purpose of remittance from one part of the United Kingdom to another. Thus the trader in Manchester, Leeds, or Birmingham, who has a payment to

make in London, remits bills of his customers in the country. These are discounted by the monied capitalists through the intervention of bill-brokers. A few of the London bankers also discount for the accommodation of their customers, and the Bank of England deals extensively in that department. The bills so cashed are transmitted to the provincial banks to be presented at maturity for payment. Conversely, in the provincial towns the country bankers discount bills on London, and transmit them to their correspondents there for payment. The rate of discount varies according to the demand for money, and the character of the particular bills; but it is seldom, upon regular transactions, more than five, or less than two and a half per cent.

Hitherto bills of exchange have been considered, in their primary application, as means of remittance, but there are other purposes equally important, which, by an intelligible transition, they have been made to serve. For, the use and properties of bills being once understood, and their validity recognised, nothing was more natural than that they should be applied to the ordinary transactions of trade. A trader desirous of purchasing a commodity for which his available funds might not enable him to pay ready money, would tender to the seller an order for payment on some other person, receiving or paying the difference, as the case might be, and making an allowance by way of interest, or, which is the same thing in other words, paying an extra price, in proportion to the time of the bill's currency. To the seller this mode of dealing would obviously be better than the giving of a naked credit, as affording him an additional chance of payment, and a written acknowledgment of his debt. Moreover, when the negotiability of inland bills was once admitted, they would serve all the purposes of actual money, because in the same manner as the original seller had been induced to take the order in payment, another might be willing to receive it from him in the purchase of other commodities; or it might be at once discounted or converted into cash by application to a money-dealer, whether bill-broker or banker, in the manner which has been already explained in speaking of remittances.

But the drawing of a bill supposes, as has been said, that the drawee either has in his possession funds of the drawer, or is his debtor to the amount specified in the order; it was therefore by an easy step that in the transactions of wholesale dealing it became a common practice for the seller to draw upon the buyer, for the price of the goods, a bill payable to his (the seller's) own order at some future day. This bill the buyer immediately accepted, and thus in effect acknowledged himself to be the debtor of the drawer to the amount specified, and engaged to pay the holder at maturity. By this arrangement, now very general, the buyer obtains credit for the term at the expiration of which the bill is made payable, and the seller has the advantage of a fixed day for payment being named in the bill, and a means of procuring cash if he chooses to negotiate the bill.

Neither was it an unreasonable extension of the principle that a bill should be drawn and accepted *on the faith of funds to be received by the drawee* at or before the maturity of the draft. At the present day this practice prevails to a great extent, and may be illustrated by a supposed case as follows:—There are established in most if not all the principal trading ports of the world, merchants who carry on the business of general factors or agents for sale, and whose establishments are known among mercantile men under the name of commission-houses. The course of dealing with such houses is, for the most part, this:—A., a manufacturer at Manchester, consigns a cargo of cotton pieces to B. and Co., a commission-house at Mexico, for sale on his account. The English correspondents of B. and Co. are Messrs. C. and Co. of London. By an arrangement among these several parties A. draws on C. and Co. for half or two-thirds, as may be agreed, of the invoice price of the goods consigned, and discounting the bill with his banker obtains at once an instalment in actual money, which immediately returns into his capital, and becomes useful in producing more goods and creating more wealth. Ultimately, account sales are furnished by the Mexican house, and A. again draws on C. and Co. for the balance, if in his favour. Annual balances are struck between B. and Co. and C. and Co., and remittances by bills for the adjustment of the account complete the transaction. The advantages of this anticipatory part-payment are obvious, more especially in the trade with distant countries, such as South America or the East Indies. But the practice has degenerated into something of an abuse. It has of late been the frequent practice of the consignors of goods to make out invoices with prices artificially high, and so to procure a remunerating return even from the proportion for which they are authorised to draw in advance. The effect is to throw upon the consignees the whole risk, which was formerly shared between the two, and proportionately to impair the steadiness and security of commerce.

Perhaps, however, if this were the only abuse of bills, there would be little to complain of—nothing, certainly, to counterbalance the immense advantages which are derived from them as instruments of exchange; but, unfortunately, of late years, the abundance of money in the English market, and the consequent facility of negotiating paper securities, the competition of trade, and the accompanying relaxation of the system of credit, with other causes which will readily suggest themselves, have given occasion to practices which are not only a wide departure from the original purposes of bills of exchange, but are most injurious to the general interests of trade. Good bills, we have

said, may be always discounted. Accordingly, any man whose credit is good may at any time raise money upon a bill drawn, accepted, or indorsed by himself. If his credit be doubtful he may still procure cash by the same expedient, paying, however, a premium or rate of discount proportioned to the increased risk. Among needy men instances are not unfrequent of discounts procured by these means even at the exorbitant rate of 20 or 30, sometimes even 70 per cent. But a still more common practice is the negotiation of what are called by the significant name of *accommodation* bills. A trader unable to meet his liabilities applies to a friend whose credit is better than his own, to accept, or in some other way to become a party to, a bill concocted for the purpose, undertaking to provide the funds necessary for paying it when due, and generally giving in return his own acceptance of another concocted bill, known in the mercantile world as a cross acceptance. When one or more names have thus been obtained sufficient to give currency to the bill, it is discounted, and the money applied to the necessities of the trader. As this bill falls due, the same operation is repeated, until the system of expedients failing at last, as sooner or later it inevitably must, the ruin of the insolvent trader himself is consummated, and not unfrequently draws along with it others who, unfortunately or imprudently, may have become parties to these unsubstantial representatives of value. Of the more serious mischiefs of this dangerous practice, such as the temptation to forgery by the use of fictitious names as drawers or payees, it is perhaps useless to speak, because few men at first seriously contemplate the commission of a crime, but are rather drawn into it by circumstances not foreseen or not appreciated; but the reflection that it is a foolish and improvident practice—that, in addition to the loss of credit, which, once perceived (and how can it fail to be perceived?), it is sure to occasion, there is the certain expense of stamps and higher rates of discount, and moreover a *double liability* in respect of every shilling for which cross acceptances are given—may perhaps have some effect in deterring honest men, however necessitous, from having recourse to this fatal expedient.

The various uses to which bills of exchange are made applicable in the great community of commerce having been thus explained, it remains only to take a glance at their legal incidents as instruments of contract.

In contemplation of law a bill of exchange, as well in its original formation as in its successive transfers, is an assignment of a debt, by which the right of the original creditor to sue for and obtain payment is transferred to the holder for the time being. In such a substitution the Roman law saw nothing objectionable; and in those countries, therefore, which adopted the civil law for their own, the negotiation of bills found no impediment. But into the common law of England had early been incorporated a doctrine, founded probably on experience of the mischief, that the assignment of a mere right such as a debt would give, being in truth the assignment of suits at law, which might be converted into an engine of oppression, was illegal and void. Bills of exchange, coming within the meaning of this doctrine, must have been extinguished by the courts of law. But, fortunately for England, the opportunity seemed not to have arisen till the danger was past: for although we have unequivocal mention of these instruments in our statute book as early as A.D. 1379 (3 Ric. II. c. 3), no case upon them before the courts is to be met with in the reports earlier than the time of James I. In the 17th century merchants had acquired a prescriptive right to the customs which they had been observing during the long interval; and these customs, including the use of negotiable bills of exchange, and forming together the law-merchant of this country, came to be received as parcel of the common law of the land. There was still, however, a reluctance in the courts of law to admit that any one but a merchant could be a party to these instruments, or that even merchants could make an inland bill in the absence of long precedent amounting to prescriptive custom in its favour; but the courts, after a short resistance, were obliged to yield both points to the convenience and necessities of modern society.

In respect of their transferability, bills of exchange long stood alone among contracts. By another property as remarkable, which they derive also from the custom of merchants, they are still distinguished from all other instruments, not under seal, known to the English law. It is a presumption of law in their favour, that these instruments are honest in their inception, and have been founded originally and transferred since upon valuable consideration; so that whilst good consideration must be proved by every one who seeks to enforce any other contract not under seal, the holder of a bill of exchange is presumed to be a holder for value, until his opponent proves the contrary, or rebuts the presumption by such a *primâ facie* case of fraud as puts the holder upon proof of his title to recover.

Of the Parties to a Bill.—Any person, whether trader or not, who is not under a legal incapacity to contract, may become party to, and thereby liable upon, a bill of exchange. Infants and married women are not personally bound by becoming parties; but the instrument, though inoperative as against them, may be available against others whose names are upon it. A person may become party to a bill, not only by his own act, but by that of his duly authorised agent. The agent ought either to sign the name of his principal without anything further, or to add to his own signature the words "per procuration for A. B.," or to make it in some way apparent upon the face of the instrument that he acts *as agent*. Otherwise, though really an agent, he renders himself personally liable by his signature, and exempts his principal. Any one who assumes to draw, accept, or indorse by procuration, knowing that he has no authority to do so, though without any intention of committing a fraud, is, upon default by the person whose authority is assumed, liable, though not upon the bill as a party, yet to a special action for deceit at the suit of a *bonâ fide* holder, or for a breach of the implied warranty that he had authority as agent to make the contract.

Each member of a trading firm, in whose business bills are usual or necessary, has an implied authority to bind his copartners by drawing, accepting, or indorsing bills, provided such bills are not joint and several: but this presumption of authority fails where the holder has covinously colluded with a partner to make the partnership funds or credit available for his own individual purposes. The acceptance of a bankrupt partner in the name of the firm, though after a secret act of bankruptcy committed by that partner, is an available security in the hands of a *bonâ fide* indorsee for value.

Joint-stock companies under the 19 & 20 Vict. c. 47, may become parties to a bill by any person, who has express or implied authority of the company for that purpose, making, accepting, or indorsing such bill in the name of the company; but as the word "limited" is an essential part of the name of a company formed with a limited liability, any bill issued without that word is not binding on the company; and the person who signs or issues the bill in this imperfect state incurs a penalty of 50*l.* and personal liability to the holder on the bill.

Of the form and other requisites of a bill.—A bill of exchange must be in writing, but no precise form of words is essential to its validity. The only requisites are that it be an order for the payment of money simply, and not for the payment of money and the performance of some other act; that it be for a sum of money certain; that it be payable at all events, and not upon a contingency, or out of a particular fund; and that the person to whom, and the person by whom, it is payable be ascertained absolutely on the face of the instrument. The forms in ordinary use are as follows:

Form of a Foreign Bill in sets.

No. *London*, 1*st Jan.* 1859.

[Stamp.]

days after sight (or days after date, or at usances) pay this my first of exchange, second and third of the same tenor and date not paid, to Messrs. A. B. and Co., or order, ten thousand francs value received of them, and place the same to account.

C. D.

Mr. E. F., *Paris.*

Form of an Inland Bill.

[Stamp.]

£100.

London, 1*st Jan.* 1859.

months after date (or "at sight," or days after date) pay Mr. A. B., or order, one hundred pounds for value received.

To Mr. E. F., *Castle-street, Liverpool.* C. D.

To take the several parts of this form in their order:

All inland bills, and such foreign bills as are drawn in England, are liable to a duty, and must be made on paper duly *stamped*, under a penalty of 50*l.*, with this further consequence, that the bill, though otherwise complete, is absolutely worthless if not on stamped paper. Foreign bills not drawn in England are of necessity excluded from the operation of this statute. But another statute requires that all such bills as have been, or purport to be, drawn abroad, shall be stamped with the proper adhesive stamp (the same to be cancelled with the name of the holder or his firm, and the day and year of his doing so,) by the holder before he shall present them for payment, or indorse, transfer, or otherwise negotiate them within the United Kingdom, subject to a penalty of 50*l.* And any person who takes such a bill without the requisite stamp affixed and cancelled, shall not be entitled to recover on it, or to make it available for any purpose whatsoever.

For inland bills, and for foreign bills drawn in the United Kingdom, and singly or otherwise than in a set of three or more, the scale is as follows:

£		£	£	*s.*	*d.*
	Not above	5	0	0	1
Above 5	and not above	10	0	0	2
„ 10	„	25	0	0	3
„ 25	„	50	0	0	6
„ 50	„	75	0	0	9
„ 75	„	100	0	1	0
„ 100	„	200	0	2	0
„ 200	„	300	0	3	0
„ 300	„	400	0	4	0
„ 400	„	500	0	5	0
„ 500	„	750	0	7	6
„ 750	„	1000	0	10	0
„ 1000	„	1500	0	15	0
„ 1500	„	2000	1	0	0
„ 2000	„	3000	1	10	0
„ 3000	„	4000	2	0	0
„ 4000	and upwards		2	5	0

For foreign bills, drawn in sets of three or more, the scale is

For every bill of each set, if the sum is			£	s.	d.
£		£			
	Not above	25	0	0	1
Above 25	and not above	50	0	0	2
„ 50	„	75	0	0	3
„ 75	„	100	0	0	4
„ 100	„	200	0	0	8
„ 200	„	300	0	1	0
„ 300	„	400	0	1	4
„ 400	„	500	0	1	8
„ 500	„	750	0	2	6
„ 750	„	1000	0	3	4
„ 1000	„	1500	0	5	0
„ 1500	„	2000	0	6	8
„ 2000	„	3000	0	10	0
„ 3000	„	4000	0	13	4
„ 4000	and upwards		0	15	0

A bill altered in any material respect after it has been once issued is in effect a new bill, and the existing stamp was exhausted by the unaltered bill. No action can be maintained in any court of law or equity upon a bill not having the proper stamp as well in denomination as in value.

A *date*, though usual, is not essential to a bill, unless drawn for a sum under 5*l*. When no date is given, the bill is presumed to be dated when drawn.

A bill in which no *time of payment* is expressed is construed to be payable on demand.

Bills, as has been said, are ordinarily made *payable* to some third person, or to the drawer himself. They may, however, be expressly made payable to bearer, and when a fictitious name is given as payee, the instrument is in legal effect payable to bearer, as against the concocters of the instrument and in favour of an innocent *bonâ fide* holder. But certainty as to the person to whom it is payable is essential to the validity of the bill, and such a bill as is payable to the secretary for the time being of a specified society is void. It must be observed that the inserting a fictitious name as payee and indorsing the bill with that name is a forgery, and punishable as such.

The words "*or order*" give to the bill its character of negotiability, but the general operation of this expression may be restricted by the payee or any other indorser, who, by the following simple form of indorsement, "Pay A. B. (or A. B. or order) *to my use*," may cast upon the next immediate holder the responsibility of seeing that the contents are duly applied.

The *sum* should be clearly expressed in the bill, and in such way as to render forgery difficult. But a blank draft or acceptance given to a third person may be filled up by him with any sum which the stamp will cover.

"*Value received*" upon a bill signifies, in general, value received from the payee, and the bill itself without these words imports so much. A *total* want of consideration is ground of defence to an action upon the bill as between immediate parties, but is not available as an answer to the claim of a holder for value who has taken the security in the regular course.

An alteration in a bill in any material part, as in the date, sum, or time when payable, will, independently of the stamp acts, render the bill wholly invalid as against any party not consenting to the alteration, and this although it be in the hands of an innocent holder. But an alteration in a part not material, or made merely for the purpose of correcting a mistake, in furtherance of the original intention of the parties, though made after the bill is complete, will not invalidate it, either as regards the stamp laws or otherwise.

Of the delivery of the bill to the payee.—The delivery of a bill of exchange in consideration of an antecedent debt suspends the right to sue for that debt during the currency of the bill; but if it be dishonoured at maturity, the original debt revives, and with it the legal remedy, provided that no act be done by the holder to prejudice or impair the claim of the drawer upon the acceptor. In like manner the taking of a bill of exchange in payment suspends for the time the lien of a seller upon goods sold and remaining in his possession; but if the bill be not paid when due, he is remitted to his right of retaining or stopping the goods before they reach the buyer.

Of the presentment, acceptance, and non-acceptance of bills.—It is usual, as already said, for the payee, or the first holder who conveniently can do so, to present the bill to the drawee for acceptance; and when a bill is drawn payable at a certain time after sight, presentment for acceptance is necessary in order to fix the date of payment, and ought to be made within a reasonable time. A foreign bill so drawn may be *circulated* for a reasonable time before acceptance, and an inland bill may also be put into circulation, though with less latitude as to time; but in either case, if the payee *keep the bill in his possession* for a longer time than is reasonable, he is guilty of *laches*, and cannot recover against the drawer.

The presentment should in all cases be made during the usual hours of business, and to the drawee himself or his agent, who is bound to return an answer within twenty-four hours.

The acceptance of any bill, whether foreign or inland, must by the law of the United Kingdom be in writing on the bill, or if there be more than one part, on one of the parts of the bill, and signed by the acceptor or some person duly authorised by him.

An acceptance may be either absolute, conditional, partial, or qualified.—An absolute acceptance is an engagement to pay the bill according to the tenor: a conditional acceptance may be to pay the bill upon a contingency; as that the drawee will pay when certain goods shall be sold, or when certain funds shall come to his hands, or the like, and in this case the acceptor is not bound until the fulfilment of the condition.

A bill may also be accepted *partially*, as to pay a sum short of that for which the bill is drawn. In all cases of a conditional or partial acceptance, the holder ought to give notice thereof to all parties whom he intends to hold liable on default.

An acceptance may also be qualified as to the time of payment or the place of payment; but in the case of inland bills a special acceptance as to the place of payment can only be made by the use of restrictive words: as for instance, "Accepted payable at Coutts & Co., and *not elsewhere*."

If the drawee refuse or neglect to accept, any third party, after protesting the non-acceptance by the drawee, may accept for the honour of the drawer or any subsequent party, and such an acceptance is called an acceptance *supra protest*, or *for honour*.

Upon the non-acceptance of a foreign bill, a protest is made by the holder before a notary public; and this protest by the custom of merchants, is become so indispensable that neglect of it by the holder will prevent him from recovering against the other parties to the bill. Inland bills need not be protested, and in practice are merely noted for non-acceptance, which itself also is a useless form.

Notice of the non-acceptance must be given with all diligence to every party to whom it is intended to resort for payment; and the want of such notice, or the delay of it beyond the time allowed by law is a discharge of all parties, who have not received due notice, from their liability. This is the law—with regard to the drawer, on the ground that he is prejudiced by not receiving immediate information of the default, so as to enable him to withdraw his effects from the hands of the drawee;—and with regard to the indorsers, for a similar reason, inasmuch as their interests may be affected by the delay. If the drawer had in truth no effects in the hands of the drawee, or no reasonable expectation that there would be effects in the drawee's hand before the maturity of the bill, or no remedy over against some other party to the bill, the omission to give the drawer notice constitutes no objection to the right of action as against him. Generally, to be quite safe, notice should be given within twenty-four hours after the dishonour, and each party on receiving such notice is allowed the same interval for communicating to those who precede him upon the bill. But no more time is allowed for giving a large number of notices than is allowed for one. And where the parties to receive it live at a distance from the party who gives notice, it suffices to *despatch* it within the time specified; but if both parties live in the same town it should be despatched so as to *reach* the other within that time. The notice may in all cases be sent by the post, and it is sufficient to show that the letter containing it was delivered into the post-office.

The death, known insolvency, or even bankruptcy of the drawee, affords no excuse, either at law or in equity, for a neglect to give due notice of non-acceptance; but any party may, by agreement, or by a subsequent admission of his liability, dispense with or waive the notice to which he is entitled; and where the residence of the party is unknown, due diligence to discover it is all that the law requires.

Of the indorsement and transfer of bills, something has been already said. No form has been prescribed by the law for the mode of indorsement, and in general the mere signature of the party is sufficient. After an indorsement in full, the holder can derive title only through the special indorsee, whose signature therefore must appear upon the bill.—An indorsement is valid though made after the bill is become due, but the holder in that case is entitled only to such advantages as might have been claimed by the last indorsee before maturity, and is liable to such counter claims as might have been set off against him.

After payment of a part, the bill may be indorsed over for the residue. Bills payable to bearer may be transferred by delivery only without indorsement. An indorsement may be restricted by the words before mentioned, "Pay A. B. to my use," or by any other expression clearly limiting the authority to assign.

A *bonâ fide* holder for value is not affected by the want of title in any previous indorser; and nothing but *mala fides* can invalidate his title, notwithstanding that the bill may have been lost or stolen from the possession of a rightful owner.

If a bill is not negotiable and has been lost or destroyed, the payee may nevertheless recover at law against the acceptor or drawer. If a negotiable bill has been lost or destroyed the rightful owner may offer an indemnity and recover against the party liable either at law or in equity; but if the rightful owner wishing to enforce payment, refuses to give an indemnity, the defendant may defeat the action at law by setting up the loss or destruction of the bill, or he may compel the other in equity to give him an indemnity and cast him in the costs of the suit.

Of the presentment for payment, &c.—The holder of a bill is bound to present it to the drawee for payment at the time when due, when a

time of payment is specified, or within a reasonable time after receipt of the bill when no time is expressed. If he neglect to do so, not only is he disabled from afterwards resorting to the drawer or indorsers—whose implied engagements are severally to pay only in case of default by the drawee, and who are always presumed to have sustained damage by such neglect on the part of the holder—but he loses also his remedy for the consideration or debt in respect of which the bill was given or transferred. As in the case of presentment for acceptance, so in that of presentment for payment, the insolvency of the acceptor does not dispense with the presentment for payment, as regards the drawer and indorsers: but to an action against the acceptor presentment is not a necessary preliminary, unless the bill has been accepted payable at a particular place *only* and *not elsewhere*; and then presentment is indispensable to charge even the acceptor. If the acceptance be qualified in this way as to the place of payment, the presentment must be made at the place so specially indicated; but in general, a presentment at the domicile of the drawee is sufficient, even though another place be named upon the bill. The presentment ought to be made on the last of the days of grace, unless that be a Sunday or holiday, and in that case on the day preceding. Bills payable on demand, or where no day of payment is expressed, are not entitled to days of grace.

The following is a statement (taken from Chitty on 'Bills of Exchange,' 10th edit.) of the usance and days of grace for bills drawn in London upon some of the chief commercial cities.

m. d., *m. s.*, *d. d.*, *d. s.*, *d. a.*, respectively denote months after date, months after sight, days after date, days after sight, days after acceptance:

London on.	Usance.	Days of Grace.
Altona	1 *m. d.*	12
Amsterdam	1 *m. d.*	none
Antwerp	1 *m. d.*	none
Bahia	none	15
Barcelona	60 *d. d.*	14
Berlin	14 *d. s.*	3
Bilboa	2 *m. d.*	14
Bordeaux	30 *d. d.*	none
Brazil	none	15
Bremen	1 *m. d.*	8
Cadiz	2 *m. d.*	6
Dantzic	14 *d. a.*	10
France	30 *d. d.*	none
Genoa	3 *m. d.*	none
Geneva	30 *d. d.*	5
Gibraltar	2 *m. s.*	14
Hamburg	1 *m. d.*	12
Leghorn	3 *m. d.*	none
Leipsic	14 *d. a.*	none
Lisbon	60 *d. d.*	6
Lisle	1 *m. d.*	none
Madrid	60 *d. d.*	14
Malta	30 *d. d.*	13
Milan	3 *m. d.*	
Naples	3 *m. d.*	none
Oporto	60 *d. d.*	6
Palermo	3 *m. d.*	none
Paris	1 *m. d.*	none
Rio Janeiro	none	15
Rotterdam	1 *m. d.*	none
Rouen	1 *m. d.*	none
Seville	60 *d. d.*	14
Sweden	30 *d. s.*	6
Switzerland	30 *d. s.*	
Trieste	14 *d. a.*	3
Venice	3 *m. d.*	6
Vienna	14 *d. a.*	3

It should be remarked, however, that many of these usances are obsolete in the strict sense of the word; and the same remark applies to days of grace. In England three days of grace are allowed and always taken, so that bills are not presentable for payment until the three days are expired.

In general, payment made on any part of the day on which the bill is presented will be sufficient; yet if payment be once refused, however early in that day, the bill is effectually dishonoured by such refusal, and recourse may be at once had to the other parties. The requisites, with respect to notice, protest for non-payment, and payment *supra protest*, &c., are the same as those which have been already given under the head of presentment for acceptance. In this country no damages are recoverable upon inland bills dishonoured, the party sued being liable only for the amount of the interest to the day on which judgment is entered up. On foreign bills duly protested the expenses occasioned by the dishonour, as re-exchange, postage, and commission, unless where a liquidated sum is agreed on between the two countries to cover all expenses in such cases, may be recovered under the name of damages, and amount sometimes to a considerable sum. But neither in this country nor in any other can compensation be claimed by the holder for losses more remotely consequential, as the expense of travelling or the disappointment of some profitable adventure.

If the holder make any agreement with the acceptor for taking a composition from him, or limiting a time within which he will not press for payment, all the other parties to the bill, being in the situation of sureties only, are exonerated from their liability by this dealing with the principal.

Payment should be made only to the person who is able to give a discharge upon the bill; and it may be refused unless the bill be delivered up. It is usual moreover and prudent to take a receipt written on the back. If payment be made by mistake, as upon a forged acceptance, indorsement, or the like, the money so paid may be recovered back from the holder, provided the discovery is made, and notice given to the holder, on the day on which the payment is made.

The forgery of a bill of exchange or of any signature thereto, as well as the uttering of any such forged bill or indorsement with a knowledge of the forgery, is a felony, punishable with transportation or penal servitude for life, or for not less than four years, and with imprisonment and hard labour not exceeding four years. (See Chitty on *Bills of Exchange*, 10th edit., by John A. Russell, LL.B., and David Maclachlan, M.A.; Byles on *Bills of Exchange;* Blackstone's *Commentaries*, by R. M. Kerr, LL.D.)

BILL OF EXCHANGE IN SCOTLAND. The general law on the subject is the same in Scotland as in England, with few exceptions. In Scotland it is not held that to make a bill negotiable, it must contain negotiable words; and the laws restricting the negotiation of bills under *5l.* does not apply to that part of Great Britain. It is usual, there, to protest both foreign and inland bills, both for non-acceptance and non-payment. When protest has been duly taken and recorded, and when the other requisites of negotiation are complied with, and there is no flaw on the face of the bill, execution may be issued immediately against the parties liable, by what is called "summary diligence," as if it were the decree of a court. This execution may be suspended, on good cause for so doing being stated, and on security being given, or the amount brought into court when these conditions are imposed.

BILL OF HEALTH. [QUARANTINE.]

BILL OF LADING, an acknowledgment signed usually by the master of a trading ship, but occasionally by some person authorised to act on his behalf, certifying the receipt of merchandise on board the ship, and engaging, under certain conditions and with certain exceptions, to deliver the said merchandise safely at the port to which the ship is bound, either to the shipper, or to such other person as he may signify by an endorsement upon the Bill of Lading.

The conditions stipulated on behalf of the master of the ship are, that the person entitled to claim the merchandise shall pay upon delivery of the same a certain specified freight, together with allowances recognised by the customs of the port of delivery, and known under the names of primage and average. Primage amounts in some cases to a considerable per centage (ten or fifteen per cent.) upon the amount of the stipulated freight, but the more usual allowance under this head is a small fixed sum upon certain packages, for example, the primage charged upon a hogshead of sugar brought from the West Indies to London is sixpence. This allowance is considered to be the perquisite of the master of the ship. Average, the claim for which is reserved against the receiver of the goods, consists of a charge divided *pro rata* between the owners of the ship and the proprietors of her cargo for small expenses (such as payments for towing and piloting the ship into or out of harbours), when the same are incurred for the general benefit.

The exceptions stipulated on behalf of the shipowners are stated in the Bill of Lading, which is usually drawn up in the following words:—

"Shipped, in good order and well conditioned, by [John Smith], in and upon the good ship called the [Mary], whereof is master [Thomas Jones], now lying in the [River Thames], and bound for [Hamburg]

[I S 1 at 100 Bags „ 1 at 7 Chests]	[One Hundred bags of Coffee, and Seven Chests of Indigo.]

marked and numbered as in the margin, to be delivered in the like good order and condition at the aforesaid port of [Hamburg] (*the act of God, the Queen's enemies, fire, and all and every other danger and accidents of the seas, rivers, and navigation, of whatever nature and kind soever excepted*) unto [Messrs. Schröder and Co.] or their assigns, they paying freight for the said goods at the following rates, namely, [One Shilling and fourpence sterling per Hundred Weight for the Coffee, and five-eighths of a penny sterling per pound for the Indigo], together with primage and average accustomed. In witness whereof, I, the said master of the said ship, have affirmed to [four] bills of lading, all of this tenor and date, any one of which bills being accomplished, the other [three] are to stand void. Dated in London, this [first] day of [June] 1859.

"Thomas Jones."

In every case where shipments are made from this country, one at least of the bills of lading must be written upon a stamp of the value of sixpence.

One of the bills (unstamped) is retained by the master of the ship, the others are delivered to the shipper of the goods, who usually transmits to the consignee of the goods one copy by the ship on board which they are laden, and a second copy by some other conveyance. In

case the ship should be lost, when the goods are insured, the underwriters require the production of one of the copies of the Bill of Lading, on the part of the person claiming under the policy of insurance as evidence at once of the shipment having actually been made, and of the ownership of the goods.

Considerable hardship was experienced up to a late period from the state of the commercial law of England as regarded pledges. A factor to whom consignments of goods should be made had full power over those goods to sell them, with or without, or even against, the instructions of the owner, but he had no right to pledge them, and if he did so the owner of the goods might insist upon their restitution from the pawnee without repaying the advances he might have made. It was impossible to know from the terms of the document whether the holder of a Bill of Lading was actually the owner of the goods represented by it, or only entrusted with them as a factor, and cases of great hardship frequently occurred, sometimes indeed not without suspicion of collusion between the owner and the factor. This law was defective, because it visited upon a third party the carelessness or error of the owner of the goods in making a false estimate of the character of the factor whom he employed, and because, on the other hand, it frequently compelled factors to sell goods at an unfavourable moment, the necessity for which course might have been averted, if they could legally have given the goods in security for an advance of money. This state of things was remedied by the statute 6 Geo. IV. c. 94, usually called "the Factor's Act," which was subsequently amended by stat. 5 & 6 Vict. c. 39. Any person in possession of a Bill of Lading is now deemed the true owner of the goods specified in it, so as to make a sale or pledge by him of such goods or bill of lading valid, unless the person to whom the goods are sold or pledged has notice that the seller or pledger is not the actual and *bonâ fide* owner of the goods.

The unavoidable practice of delivering more than one bill of lading as an acknowledgment for the same goods (of the shipment of which the bill of lading is as against the master conclusive evidence), makes it necessary to protect the master against demands made for the delivery of the goods in the possible case of different copies of the Bill of Lading falling into the possession of different persons. In such case all that is required from the master is, that he, acting in perfect good faith, and without any reasonable suspicion of fraud on the part of the person first making the demand for delivery, shall comply with the same to the person so first demanding the goods by the presentation of the Bill of Lading. The property in the goods represented by a Bill of Lading, and all the rights and liabilities of the parties thereto, *inter se* (18 & 19 Vict. c. 111), can be assigned like a bill of exchange by indorsement, which may be either in blank or special. In the event of the first mode being used, as the document might accidentally fall into improper hands—a fact which the master of a ship could not reasonably be expected to discover—he is free from responsibility when acting without collusion. Should he, on the other hand, act either negligently or collusively in the matter, the law will compel him to make good their value to the real owner of the goods.

BILL OF RIGHTS is the name commonly given to the statute 1 William and Mary, sess. 2, chap. 2, in which is embodied the Declaration of Rights, presented by both Houses of the Convention to the Prince and Princess of Orange, in the Banqueting House at Whitehall, on the 13th of February, 1689, and accepted by their highnesses along with the crown. The Bill of Rights was originally brought forward in the first session of the parliament into which the Convention was transformed; but a dispute between the two Houses with regard to an amendment introduced into the bill by the Lords, naming the Princess Sophia of Hanover and her posterity next in succession to the crown after the failure of issue to King William, which was rejected in the Commons by the united votes of the high church and the republican parties, occasioned the measure to be dropped, after it had been in dependence for two months, and the matter of difference had been agitated in several conferences without effect. The bill was however again brought in immediately after the opening of the next session, on the 19th of October, 1689, and the amendment respecting the Princess Sophia not having been again proposed, it passed both houses, and received the royal assent in the same shape in which it had formerly passed the Commons, with the addition only of a clause inserted by the Lords, enacting that the kings and queens of England should be obliged, at their coming to the crown, to take the test in the first parliament that should be called at the beginning of their reign, and that if any king or queen of England should embrace the Roman Catholic religion, or marry with a Roman Catholic prince or princess, their subjects should be absolved of their allegiance. This remarkable clause is stated to have been agreed to without any opposition or debate.

The Bill of Rights, after declaring the late King James II. to have done various acts, which are enumerated, utterly and directly contrary to the known laws and statutes and freedom of this realm, and to have abdicated the government, proceeds to enact as follows:—

"1. That the pretended power of suspending of laws, or the execution of laws, by regal authority, without consent of parliament, is illegal. 2. That the pretended power of dispensing with laws, or the execution of laws, by regal authority, as it hath been assumed and exercised of late, is illegal. 3. That the commission for creating the late court of commissioners for ecclesiastical causes, and all other commissions and courts of like nature, are illegal and pernicious. 4. That levying of money for or to the use of the crown, by pretence of prerogative, without grant of parliament, for longer time, or in other manner, than the same is or shall be granted, is illegal. 5. That it is the right of the subjects to petition the king, and all commitments and prosecutions for such petitioning are illegal. 6. That the raising or keeping a standing army within the kingdom in time of peace, unless it be with consent of parliament, is against law. 7. That the subjects, which are protestants, may have arms for their defence, suitable to their condition, and as allowed by law. 8. That election of members of parliament ought to be free. 9. That the freedom of speech, and debates or proceedings in parliament, ought not to be impeached or questioned in any court or place out of parliament. 10. That excessive bail ought not to be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted. 11. That jurors ought to be duly empanelled and returned, and jurors which pass upon men in trials for high treason ought to be freeholders. 12. That all grants and promises of fines and forfeitures of particular persons, before conviction, are illegal and void. 13. And that for redress of all grievances, and for the amending, strengthening, and preserving of the laws, parliaments ought to be held frequently."

It is added that the Lords and Commons "do claim, demand, and insist upon all and singular the premises as their undoubted rights and liberties; and that no declarations, judgments, doings, or proceedings, to the prejudice of the people in any of the said premises, ought in anywise to be drawn hereafter into consequence or example."

The act also recognises their Majesties William III. and Mary as King and Queen of England, France, and Ireland, and the dominions thereunto belonging; and declares that the crown and royal dignity of the said kingdoms and dominions shall be held by their said majesties during their lives and the life of the survivor of them; that the sole and full exercise of the regal power shall be only in and executed by King William, in the names of himself and her majesty, during their joint lives; and that after their decease the crown shall descend to the heirs of the body of the queen, and, in default of such issue, to the Princess Anne of Denmark and the heirs of her body, and, failing her issue, to the heirs of the body of the king.

The Declaration of Rights is understood to have been principally the composition of Lord (then Mr.) Somers, who was a member of the first, and chairman of the second, of two committees, on whose reports it was founded. The original draught of the Bill of Rights was also probably the production of his pen. In the latter especially, there is very apparent a desire to preserve in the new arrangement as much as possible of the principle of hereditary succession to the crown. The legislature, for instance, in strong terms expresses its thankfulness that God had mercifully preserved King William and Queen Mary to reign over them "upon the throne of their ancestors;" and the new settlement is cautiously designated merely "a limitation of the crown." Mr. Burke has, from these expressions, contended (in his 'Reflections on the Revolution in France') that the notion of the English people having at the Revolution asserted a right to elect their kings is altogether unfounded. "I never desire," he adds, in repudiation of the opposite opinion as held by one class of persons professing Whig principles, "to be thought a better Whig than Lord Somers, or to understand the principles of the Revolution better than those by whom it was brought about, or to read in the Declaration of Rights any mysteries unknown to those whose penetrating style has engraved in our ordinances and in our hearts the words and spirit of that immortal law."

It has been sometimes stated, even so lately as by Lord Macaulay in his 'History' (as is pointed out by Mr. Knight in his 'Popular History of England'), that this act "deprived the crown of the power of arbitrarily removing the judges;" but neither the act, nor the Declaration of Rights which preceded it, contains a word on the subject. It was effected, however, by the Act of Settlement (13 Wm. III. c. 2), in 1701. Equally erroneous has been the assigning of this measure to the 1 George III. c. 2, which has been even more generally done. This act merely provided that the judges should not be removeable on the accession of a new sovereign.

The Declaration and Bill of Rights may be compared with the Petition of Rights (drawn up by Sir Edward Coke), which was presented by parliament to Charles I. in 1628, and passed by him into a law. [PETITION OF RIGHT.]

BILL OF SALE, a deed or writing under seal, evidencing the sale of personal property. In general, the transfer of possession is the best evidence of ownership, but cases frequently occur in which it is necessary or desirable that the change of property should be attested by a formal instrument of transfer; and in all cases in which it is not intended that the sale shall be followed by delivery, such a solemnity is essential to the legal efficacy of the agreement. The occasions to which these instruments are commonly made applicable are sales of fixtures and furniture in a house, of the stock of a shop, of the goodwill of a business (which of course is not transferable by delivery), of an office, or the like. But their most important use is in the transfer of property in ships, which being held in shares cannot, in general, be delivered over on each change of part ownership. It seems to have been from ancient times the practice, as well in this country as in other commercial states, to attest the sale of ships by a written

document; and at the present day a bill of sale is necessary to the validity of all transfers of shares in British ships, whether by way of sale or of mortgage, and the instrument must be registered at the port where the ship is registered. (17 & 18 Vict. c. 104.) In general, bills of sale, being *ex vi termini* founded on valuable consideration, are available against the creditors of the seller. But by the operation of the Bankruptcy laws, goods remaining with the consent of the true owner in the order and disposition of the insolvent at the time of his bankruptcy, are deemed to be the property of the latter, and pass to his assignees to be distributed with the rest of his effects for the benefit of his creditors. In all cases, a bill of sale of *personal chattels* must be registered, within twenty-one days after the making thereof, in the judgment office of the Queen's Bench, otherwise it will, as against assignees in bankruptcy or insolvency, or creditors, be null and void. (17 & 18 Vict. c. 36.) Moreover, in all cases such a deed may be set aside on proof that it was a merely colourable and fraudulent expedient for defeating the claim of *bonâ fide* creditors, the courts of law being little disposed to favour assignments of this kind, made secretly and without the notoriety which attends the actual transfer of possession.

BILLON, in coinage, is a composition of precious and base metal, consisting of gold or silver alloyed with copper, in the mixture of which the copper predominates. The word came to us from the French. According to Boutteroue, in France, billon of gold was any gold beneath the standard of twenty-two carats fine; and billon of silver all below ten pennies fine. Boizard says that gold beneath the standard as far as twelve carats fine, and silver to six pennies fine, were properly base gold and base silver; but that it was the mixture under those quantities which made billon of gold and billon of silver, in consequence of copper being the prevailing metal. Black money, or billon, was struck in the mints of the English dominions in France, by command of the kings of England, for the use of their French subjects. Money of billon was common throughout France from about the year 1200. Hardies, authorised money of Edward the Black Prince, are also found of similar mixture. It was probably one consideration with Henry VIII. in coining base money, that it would circulate in France to his advantage. Henry VIII. and Queen Elizabeth both coined base money, approaching to billon, for the use of Ireland.

Nothing precisely corresponding to billon is now coined by any of the great European states; although in some the abasement, or alloy, of gold and silver coinage is carried to a much greater extent than in England.

BILLS OF MORTALITY, are returns of the deaths which occur within a particular district, specifying the numbers that died of each different disease, and showing, in decennial or smaller periods, the ages at which decease took place. When the accuracy of these returns can be depended upon, facts of great importance in their actual application to the business of life may be deduced from them. From the mortuary tables, commenced at Geneva in 1566, which have been continued until the present time, it is ascertained that at the Reformation one-half of the children born died within the sixth year; in the 17th century, not till within the twelfth year; and in the 18th century, not until within the twenty-seventh year. Tables of this description, extending over a long period, mark the progress of a country in wealth and happiness; and the share which political causes have had in producing the results which they indicate, is a subject worthy of the highest consideration of the statesman and politician. The Northampton Tables of Mortality, also the Carlisle Tables, and the Swedish Tables, have served as the chief basis on which annuities, life insurances, and other calculations relating to the duration of human life, have been founded. The London Bills were commenced after a great plague in 1593. The weekly bills were begun in 1603, after another visitation of still greater severity. Imperfect as these documents are, there does not exist a complete collection of them, not even in the British Museum. In London, the Bills of Mortality included the City of London, the City and Liberties of Westminster, the Borough of Southwark, and thirty-four out-parishes in Middlesex and Surrey, the whole containing a population of 1,178,374 in 1831; but they did not contain St. Luke's, Chelsea, population, 32,371; Kensington, 20,902; St. Mary-le-bone, 122,206; Paddington, 14,540; and St. Pancras, 103,548;—total, 293,567. In the year in which the census was taken (1831) the number of deaths published in the annual Bill of Mortality was 25,337, or 1 in 46, on a population, as above stated, of 1,178,374.

In 1837 this system, if system it could be called, was wholly abolished by the passing of the Registration Act of the 6 & 7 Will. IV. c. 86, by which returns of all the births, deaths, and marriages, in England and Wales were secured, and which was extended to Scotland in 1854, by the 17 & 18 Vict. c. 80. [Registration of Births, Deaths, and Marriages.]

BINARY COMPOUNDS. [Nomenclature, Chemical.]

BINARY THEORY. [Salts.]

BINETHIDE OF TIN. [Organometallic Bodies.]

BINITROBENZOIC ACID. [Benzoic Acid.]

BINITROBENZOLE, *Dinitrobenzole*. [Benzole.]

BINITRONAPHTHALIN, *Dinitronaphthalin*. [Naphthalin.]

BINNACLE, an article used on board ship which contains the compass. It is placed next the steersman, and is often divided into compartments for containing an hour-glass and a lamp. In order that the compass may remain unaffected by any local cause, the binnacle is not put together with nails or any iron work. The binnacle has of late become an object of great consideration, from its being made to contain arrangements of correcting magnets and soft iron, on principles so ably worked out by Professor Airy. [Local Attraction.] Bittacle, being an abbreviation of the French word *habitacle*, a small habitation, was the name formerly given to this article, and it is so called in Johnson's 'Dictionary;' but it is now written binnacle.

BINOMIAL, in algebra, means an expression which contains two terms, such as

$$a+b \qquad b-cx \qquad a^2x-py.$$

Any expression may be considered and used as a binomial in any sense in which it may be said to contain two terms: thus,

$$a+b+cx-ex$$

when put in the form

$$(a+b)+(c-e)x$$

is a binomial, the terms of which are $a+b$ and $(c-e)\,x$.

BINOMIAL EQUATION. [Equation, Binominal.]

BINOMIAL THEOREM, by far the most important theorem in common algebra, first announced by Newton, as will presently appear. It is frequently called on the Continent the *binome de Newton*, and is often said, but wrongly, to have been engraved on his tomb in Westminster Abbey. In explaining this theorem, we shall consider ourselves as writing for those who have already such a knowledge of algebra as will enable them easily to recognise the various expressions of which we make use.

The binomial theorem, coupled with those preceding theorems from which it springs, is as follows:—

(1.) If a be denoted by a^1, aa by a^2, and aaa by a^3, &c., then

$$a^m \times a^n = a^{m+n} \qquad \frac{a^m}{a^n} = a^{m-n}\,(m > n).$$

(2.) The equations in (1.) will hold good when the symbol a^0 is considered, provided that a^0 always signifies *unity*.

(3.) The equations in (1.) will hold good when negative exponents are employed, provided that

$$a^{-1} \text{ means } \frac{1}{a} \qquad a^{-2} \text{ means } \frac{1}{a^2}, \text{ &c.}$$

(4.) The equations in (1.) will hold good when fractional exponents are employed, provided that

$a^{\frac{1}{2}}$ means the square root of a

$a^{\frac{1}{3}}$ „ „ cube root of a

$a^{\frac{1}{4}}$ „ „ fourth root of a, &c.

and also that

$a^{\frac{2}{3}}$ means $(a^2)^{\frac{1}{3}}$ the cube root of a^2

$a^{\frac{4}{7}}$ „ $(a^4)^{\frac{1}{7}}$ the seventh root of a^4

$a^{\frac{m}{n}}$ „ $(a^m)^{\frac{1}{n}}$ the nth root of a^m.

(5.) *Binomial Theorem.* In all the preceding cases, that is, whether n be whole or fractional, positive or negative,

$$(1+x)^n = 1 + nx + n\,\frac{n-1}{2}\,x^2 + n\,\frac{n-1}{2}\,\frac{n-2}{3}\,x^3$$
$$+ n\,\frac{n-1}{2}\,\frac{n-2}{3}\,\frac{n-3}{4}\,x^4 + \text{&c.},$$

the preceding being a series of an infinite number of terms in all cases, except only where n is a positive whole number. The pth term of the preceding expression is

$$n\,\frac{n-1}{2}\,\frac{n-2}{3}\,\ldots\ldots\,\frac{n-p+2}{p-1}\,x^{p-1},$$

which expresses any term after the second.

(6.) The preceding series is convergent, whatever may be the value of n, whenever x is less than 1. If x be greater than 1, it is always divergent; but the series remaining after any term may be expressed in a finite form, as follows: Let v_1, v_2, v_3, &c., represent the several terms of the preceding series, then all the terms after the pth term are an algebraical development of a term of the form

$$v_{p+1}\ (1+\theta x)^{n-p},$$

where θ is a function of x, the arithmetical value of which is less than unity, so that

$$(1+x)^n = v_1 + v_2 + \ldots\ldots + v_p + v_{p+1}\ (1+\theta x)^{n-p}$$

$$v_1 = 1 \qquad v_2 = nx \qquad v = n\,\frac{n-1}{2}\,x^2, \text{ &c.}$$

The preceding theorem, though theoretically necessary to those who do not allow the use of divergent series, is of no practical use in the determination of $(1+x)^n$, since the determination of θ itself is the more difficult problem of the two.

We shall now give the early history of this theorem, with some remarks upon its demonstration.

Before the time of Vieta, no materials for its expression were in the hands of algebraists. That writer first used general symbols of determinate number: and in his works we find the first rude cases of the binomial theorem, though only in the results of simple multiplications, and without the discovery of any law of connexion among the coefficients. For instance, in his 'Ad Logisticen speciosam Notæ priores,' we find the following:

"Sit latus unum A, alterum B. Dico A quad.-quadratum + A cubo in B quater, + A quadrato in B quadratum sexies, + A in B cubum quater, + B quad.-quadrato, æquari A + B quad.-quadrato." This we should now express thus:

$$(a+b)^4 = a^4 + 4\,a^3\,b + 6\,a^2\,b^2 + 4\,a\,b^3 + b^4.$$

The coefficients of the binomial theorem, in the case of a whole exponent, had long been derived from the method employed in what Pascal called the Arithmetical Triangle, and Briggs the *abacus* πάγχρηστος. To trace the history of this method would here lead us too far [FIGURATE NUMBERS]; it must suffice to say that Lucas Pacioli, Stifel, Stevinus, Vieta, and others, all had in their possession something from which, if we did not know that such simple relations were difficult to discover, we should say a little attention would have enabled them to find the first glimpse of the binomial theorem, which, as we shall proceed to state, occurred to Briggs.

The *abacus* of the last-mentioned writer above alluded to is as follows (we have only reversed right and left):

1	1	1	1	1 &c.
2	3	4	5	6 &c.
3	6	10	15	21 &c.
4	10	20	35	56 &c.
5	15	35	70	126 &c.
&c.	&c.	&c.	&c.	&c.

In which each number is formed by adding that on the left to that immediately above. On which ('Trigonometria Britannica,' 1633, preface, p. 22) Briggs remarks, that by ascending obliquely, the coefficients of the several powers are obtained; for instance, that 4, 6, 4 are the coefficients of the fourth power, 5, 10, 10, 5, of the fifth power, and so on. Briggs therefore knew the dependence of these coefficients on the preceding columns of figurate numbers, but not the algebraical expression for the nth of each class.

The next step was made by Wallis, in his 'Arithmetica Infinitorum,' published in 1655. One of the great objects of this work was the determination of the areas of a class of curves, involving a problem amounting to the determination of

$$\int (1-x^2)^m\,dx \quad \text{from } x=0 \quad \text{to } x=1$$

where m is a whole number. In this he deduces the algebraical expressions for any figurate number, but not in the form in which Newton afterwards gave. For example, he prefers

$$\frac{l^3+3\,l^2+2\,l}{6} \text{ to } l\,\frac{l+1}{2}\,\frac{l+2}{3},$$

though it appears he knew the latter form. But he confined himself almost entirely to the *definite* integral, and did not exhibit his results in the form of algebraic series. His work is broken into propositions, after the manner of the ancients, and the simple form in which Newton afterwards enunciated his results does not appear (that we can find) in his work. It was as follows, using the notation already adopted, or rather Newton expressed it as follows, and in the method of expression is the happy simplification which led him to the binomial theorem. In the first column is the expression of the ordinate of the curve in question; in the second, the area included between the abscissa, the ordinates at its extremities, and the intercepted curve.

$(1 \pm x^2)^0$	x
$(1 \pm x^2)^1$	$x \pm \frac{1}{3}x^3$
$(1 \pm x^2)^2$	$x \pm \frac{2}{3}x^3 + \frac{1}{5}x^5$
&c.	&c.

Wallis had suggested that the method of determining the area of the circle depended upon finding a mean term between 1 and $\frac{2}{3}$ in the series, 1, $\frac{2}{3}$, $\frac{8}{15}$, made by taking the lower sign in the preceding set, and making $x=1$ (he was considering the total areas). For the ordinate of the circle being $\sqrt{1-x^2}$, the exponent of which is $\frac{1}{2}$, the mean between 0 and 1, the question reduced itself to this: If 0, 1, 2, &c., operated upon according to a certain law, give the results 1, $\frac{2}{3}$, $\frac{8}{15}$, &c., what will $\frac{1}{2}$ give when operated upon according to the same law? This interpolation he attempted, and obtained his well known and remarkable expression for the ratio of the circular area to the square on its diameter. But he could not succeed in the interpolation, and as he informs us himself in his 'Algebra,' afterwards published in 1685, "he gave it over as a thing not feasible," one difficulty being that he could not imagine a series with more than one term and less than two, which it seemed to him the interpolated series must have. And here the question rested till it was taken up by Newton. The latter, in a celebrated letter to Oldenburg, dated October 24, 1676, speaking of some developments then newly discovered by Leibnitz, gives the binomial theorem. We shall give his own words (that is, translated from the Latin): "In the beginning of my mathematical studies, when I happened to meet with the works of our celebrated Wallis, in considering the series, by the intercalation of which he exhibits the area of the circle and hyperbola." . . . . He then goes on to describe what we have already alluded to . . . . "for interpolating between these I remarked that in all the first term was x, and the second terms were in arithmetical progression . . . . that the two first terms of the series to be intercalated should be

$$x - \frac{\frac{1}{2}\,x^3}{3} \qquad x + \frac{\frac{1}{2}\,x^3}{3}, \text{ &c.}$$

For the remaining intercalations I reflected that the denominators were in arithmetical progression; so that only the numerical coefficients of the numerators remained to be investigated. But these, in the alternate areas, were the figures of the powers of the number eleven, namely 11^0, 11^1, 11^2, 11^3, 11^4; that is, in the first 1; in the second, 1, 1; in the third, 1, 2, 1; in the fourth, 1, 3, 3, 1; in the fifth, 1, 4, 6, 4, 1. I inquired, therefore, in what manner all the remaining figures could be found from the first two; and I found that if the first figure be called m, all the rest could be found by the continual multiplication of the terms of the formula

$$\frac{m-0}{1} \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times, \text{ &c.}$$

"This rule, therefore, I applied to the interpolation of the series. And since in the circle the second term is $\frac{1}{3} \times \frac{1}{2}\,x^3$, I made $m=\frac{1}{2}$ . . . . . whence I found the required area of the circular segment to be

$$x - \frac{\frac{1}{2}\,x^3}{3} - \frac{\frac{1}{8}\,x^5}{5} - \frac{\frac{1}{16}\,x^7}{7} - \frac{\frac{5}{128}\,x^9}{9} - \text{ &c.}$$

"This was my first introduction to such meditations, and it would have gone out of my memory, had I not cast my eyes on some of my notes a few weeks since. *But when I had learned these things, I presently considered that the terms themselves* $(1-x^2)^0, (1-x^2)^1, (1-x^2)^2$, &c., *might be interpolated in the same manner as the areas generated from them*, and that nothing more was necessary except the omission of the denominators 1, 3, 5, 7, &c. in the terms expressing the areas: that is, that the coefficients of the quantity to be intercalated $(1-x^2)^{\frac{1}{2}}$, or $(1-x^2)^{\frac{3}{2}}$, or generally $(1-x^2)^{\frac{m}{n}}$ would arise from continual multiplication of the terms of the series,

$$m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \text{ &c.}"$$

Newton then proceeds to relate that he proved these operations by actual multiplication, and afterwards by applying the common rule for the extraction of roots, which gave the same results. He then states that he knew the common logarithmic series by the same method, and that being then much pleased with such investigations, he continued them until the appearance of Mercator's 'Logarithmotechnia'; when, suspecting that Mercator had made the same discoveries (which however was not the case) before he (Newton) was of an age to write, he began to care little about prosecuting his researches.

It must be noticed that Newton had previously given the theorem itself in a former letter to Oldenburg, dated June 13, 1676, with more copious examples; the statement of it is as follows: "The extraction of roots is much shortened by this theorem.

$$(\mathrm{P} + \mathrm{P}\,\mathrm{Q})^{\frac{m}{n}} = \mathrm{P}^{\frac{m}{n}} + \frac{m}{n}\,\mathrm{A}\,\mathrm{Q} + \frac{m-n}{2n}\,\mathrm{B}\,\mathrm{Q} + \text{ &c.}$$

where A means the first term itself, B the second term," &c.

It must therefore be noticed, and similar things are common in the history of discovery, that several of those theorems which are now among the simple consequences of the binomial theorem, were in fact discovered before it. Thus Mercator and James Gregory had already used the logarithmic series, and Newton's discovery itself was not a consequence of any attempt at the general development of $(1+x)^n$, but of the series for $\int (1-x^2)^n\,dx$, which was (between certain limits) implied in the discoveries of Wallis.

Newton gave no other demonstration of his theorem except the verification by multiplication or actual extraction. The theorem of Stirling (commonly called after Maclaurin) and that of Taylor, being the general theorems of which the binomial is a particular case, soon diverted the attention of mathematicians. James Bernoulli first demonstrated the case of whole and positive powers by the application of the theory of combinations, in his treatise 'De Arte Conjectandi,' published after his death in 1713. Maclaurin, in his fluxions, published in 1742, gave, as we consider, the first general demonstration: for though he employs fluxions, yet he had not, as he himself notices (page 607), "made use of this theorem in demonstrating the rules in the direct method of fluxions." In later times, when the avidity with which the results of modern analysis were sought began so far to subside as to allow mathematicians to look at and discuss the grounds on which the several principles were established, a host of demonstrations appeared, each of which met with objectors: for it is a

property of all the fundamental theorems of every branch of mathematics to be incapable of establishment in a manner in which all shall agree, though the theorems themselves are held indisputable. Among these demonstrations are those of James Bernoulli, Maclaurin, Landen, Epinus, Stewart, Euler, Lagrange, L'Huilier, Manning, Woodhouse, Hutton, Bonnycastle, Knight, Robertson, Creswell, Swinburne, and Tylecote. We shall not discuss the various objections, because they apply as much to the general doctrine of infinite series as to the binomial theorem in particular; and we must refer the reader to TAYLOR'S THEOREM. We shall however allude to the principal objections after we have given what appears to us a sufficient proof of the theorem, or rather after we have indicated the steps of such a proof.

Definition.—By $(1+x)^{\frac{m}{n}}$ we mean (m and n being whole numbers) a quantity which, multiplied $n-1$ times by itself, gives $(1+x)^m$; and by the expansion of $(1+x)^{\frac{m}{n}}$, we mean an algebraical series of powers of x (positive or negative, whole or fractional) which has all the algebraical properties of $(1+x)^{\frac{m}{n}}$, and which, when it is convergent, has $(1+x)^{\frac{m}{n}}$ for its arithmetical limit or sum.

Theorem 1.—The well-known proof of the expansion of $(1+x)^m$, where m is a positive whole number, giving

$$(1+x)^2 = 1+2x+x^2$$
$$(1+x)^3 = 1+3x+3x^2+x^3 \text{ \&c.}$$

This theorem is not absolutely necessary, as we shall see.

Theorem 2.—If there be any function of a, namely ϕa, which satisfies the condition

$$\phi(a) \times \phi(b) = \phi(a+b),$$

then $\phi(a)$ must be c , where c is any quantity independent of a.

For the condition gives

$$\phi(a) \times \phi(b+c) = \phi(a+b+c)$$
$$\text{or } \phi(a) \times \phi(b) \times \phi(c) = \phi(a+b+c) \text{ \&c.}$$

which leads (supposing b, c, &c., to be severally equal to a) to the equations

$$(\phi a)^n = \phi(na) \quad (\phi a')^m = \phi(ma'), \text{ \&c.}$$

where n and m are any whole numbers, and a, a', &c., any quantities whatsoever. Let us suppose $ma' = na$, which gives

$$\phi(ma') = \phi(na) \text{ or } (\phi a')^m = (\phi a)^n$$
$$\text{or } \phi a' = (\phi a)^{\frac{n}{m}} \text{ or } \phi\left(\frac{n}{m}\, a\right) = (\phi a)^{\frac{n}{m}}.$$

Again, the supposed universality of the first equation gives

$$\phi(0) \times \phi(a) = \phi(a+0) = \phi(a)$$

or $\phi(0) = 1$: and also

$$\phi(a) \times \phi(-a) = \phi(a-a) = 1$$

whence $\phi(-a) = \dfrac{1}{\phi a}$ $\quad \phi(-na) = \dfrac{1}{\phi(na)}$

$$= \frac{1}{(\phi a)^n} \quad = (\phi a)^{-n}$$

so that the equation $\phi(na) = (\phi a)^n$ is true for all values of n: if a be $= 1$, this gives $\phi n = \{\phi(1)\}^n$, and $\phi(1)$ is not a function of the general symbol n: let $\phi(1) = c$, which gives the theorem asserted.

This theorem is the fundamental part of Euler's proof of the binomial theorem.

Theorem 3.—If the values of a and b may be made as near to equality as we please, then the limit of the fraction

$$\frac{a^n - b^n}{a-b} \text{ is } n\,a^{n-1}$$

In the case where n is a whole number, this is evident by the well-known theorem

$$(a^2-b^2) \div (a-b) = a+b$$
$$(a^3-b^3) \div (a-b) = a^2+ab+b^2$$
$$(a^4-b^4) \div (a-b) = a^3+a^2b+ab^2+b^3 \text{ \&c.}$$

Let n be a positive fraction, for instance, $\frac{2}{3}$; and let $a = \alpha^3$, $b = \beta^3$. Then $a^{\frac{2}{3}} = \alpha^2$, $b^{\frac{2}{3}} = \beta^2$ and

$$\frac{a^{\frac{2}{3}} - b^{\frac{2}{3}}}{a-b} = \frac{\alpha^2 - \beta^2}{\alpha^3 - \beta^3} = \frac{\alpha+\beta}{\alpha^2+\alpha\beta+\beta^2}$$

the limit of which, when a approaches to b, is $2\alpha \div 3\alpha^2$ or $\frac{2}{3}\alpha^{-1}$ or $\frac{2}{3}\alpha^{-\frac{1}{3}}$ or $\frac{2}{3}a^{\frac{2}{3}-1}$. In the same way any other case may be proved.

Now let n be negative, say it is $-t$, where t is positive. Then

$$\frac{a^n - b^n}{a-b} = \frac{a^{-t} - b^{-t}}{a-b} = -\frac{1}{a^t\, b^t}\,\frac{a^t - b^t}{a-b}$$

of which the limit, by the two preceding cases (t being positive), is

$$-a^{-2t} \times t\,a^{t-1} \text{ or } -t\,a^{-t-1} \text{ or } n\,a^{n-1}.$$

Theorem 4.—If $(1+x)^n$ admit of being expanded in a series of whole powers of x, then that series must be

$$1 + nx + n\,\frac{n-1}{2}\,x^2 + n\,\frac{n-1}{2}\,\frac{n-2}{3}\,x^3 + \ldots$$

Let

$$(1+x)^n = t_0 + t_1 x + t_2 x^2 + \text{\&c.}$$
$$(1+y)^n = t_0 + t_1 y + t_2 y^2 + \text{\&c.}$$
$$\frac{(1+x)^n - (1+y)^n}{(1+x) - (1+y)} = t_1 + t_2\,\frac{x^2-y^2}{x-y} + \text{\&c.}$$

which two sides being always equal, the limits to which they approach, as x approaches to y, are equal; or

$$n\,(1+x)^{n-1} = t_1 + 2\,t_2\,x + 3\,t_3\,x^2 + \text{\&c.}$$

Multiply both sides by $1+x$, which gives

$$n\,(1+x)^n = t_1 + (2\,t_2 + t_1)\,x + (3\,t_3 + 2\,t_2)\,x^2 + \text{\&c.}$$

but by the original assumption

$$n\,(1+x)^n = n\,t_0 + n\,t_1\,x + n\,t_2\,x^2 + \text{\&c. and}$$

therefore

$$t_1 = n\,t_0$$
$$2\,t_2 + t_1 = n\,t_1 \text{ or } t_2 = n\,\frac{n-1}{2}\,t_0$$
$$3\,t_3 + 2\,t_2 = n\,t_2 \text{ or } t_3 = n\,\frac{n-1}{2}\,\frac{n-2}{3}\,t_0$$
$$\text{\&c.} \qquad \text{\&c.}$$

But, making $x = 0$ in the original series, we find $t_0 = (1)^n = 1$. Whence follows the theorem.

Theorem 5.—The value of $(1+x)^n$ is in all cases the series above investigated.

Consider that series as a function of n. Or let

$$\phi(n) = 1 + nx + n.\,\frac{n-1}{2}\,x^2 + \text{\&c.}$$
$$\phi(m) = 1 + mx + m\,\frac{m-1}{2}\,x^2 + \text{\&c.}$$

Actual multiplication will be found to give

$$\phi n \times \phi m = 1 + (m+n)\,x + \frac{m+n}{m+n}\,\frac{m+n-1}{2}\,x^2 + \text{\&c.}$$

or $\phi n \times \phi m = \phi(n+m)$.

Or we may dispense with this multiplication by remembering that since ϕn is $(1+x)^n$ and ϕm is $(1+x)^m$, when n and m are whole numbers, we must have, *in that case* (Theorem 1.),

$$\phi n \times \phi m = (1+x)^{m+n} = \phi(m+n)$$

but the result of a multiplication does not depend upon the values of the letters; if therefore ϕm and ϕn give $\phi(m+n)$ when m and n are any whole numbers, they give the same result when m and n are fractional or negative. But we do not yet know that ϕm in the latter cases represents $(1+x)^m$. But by theorem (2.) it follows from $\phi m \times \phi n = \phi(m+n)$ that ϕn is $\{\phi(1)\}^n$, or

$$\left(1 + 1\,x + 1\,\frac{1-1}{2}\,x^2 + \text{, \&c.}\right)^n \text{ or } (1+x)^n.$$

The greater part of the preceding proof is a concession to the *analytical* taste of the age, which requires that synthetical demonstration shall not appear in algebra. The theorem is demonstrated rigorously so soon as it shall be proved that from $\phi m \times \phi n = \phi(m+n)$, it necessarily follows that ϕm is $\{\phi(1)\}^m$, and that the series above-mentioned satisfies the equation just named. And in reading the objections which have been made against the various proofs of the binomial theorem, the student must bear in mind that there is one class of objections against the the actual logic of the processes, and another arising out of the conventions already alluded to. Against the demonstration of Euler, which consists in theorems 2. and 5. of the preceding, one says that it is "tentative" (*synthetical* would have been the proper word); another that it is not "algebraical," meaning *analytical*, and assuming that algebra must be analysis. To all of which we should reply by another question—Is it logical deduction from self-evident premises?

The last attempt to produce an unanswerable demonstration of the binomial theorem was made by Messrs. Swinburne and Tylecote of St. John's College, Cambridge (Deighton, 1827). The details are much too complicated to describe, but the general result is the expansion of $(1+x)^n$ to any number of terms, with a finite expression for the remainder. This expression is however so complicated and long, that it can be of no use, except as proved that the remainder can be assigned by the ordinary operations of algebra. The proof is certainly, if the details be correct, of a logical character, but it is far above the student. The remarks on other demonstrations in the preface, though dissenting entirely from many of them, we should recommend to the attention of the advanced student, as an exercise in the consideration of objections. At the same time we may recommend the remarks in Woodhouse's 'Analytical Calculations.'

BINOXIDE OF PHENYL. [OXYPHENIC ACID.]

BINOXIDE OF PROTEIN. [PROTEIN.]

BIOGRAPHY, a modern term, and one indeed of only recent introduction, formed from the Greek βίος (*bios*), 'life,' and γραφὴ (*graphe*), 'writing;' and therefore signifying literally 'life-writing.' It is that department of literature which treats of the actions and fortunes of individuals. Biography is commonly distinguished from history by the latter term being confined to the narration of the actions and fortunes, not of individuals, but of the large communities of men called states and nations; but properly biography is only a branch of history. Thus Thomas Stanley, in the preface to his 'History of Philosophy,' observes, "There are two kinds of history; one represents general affairs of state, the other gives account of particular persons, whose lives have rendered them eminent." At the time when this was written (the middle of the 17th century) the word biography, we believe, had not been invented. Stanley adds, "Homer hath given an essay of each; of the first in his Iliads, a relation of a war between different nations; of the second in his Odysseys, confined to the person of Ulysses."

Owing to this their natural connection, history and biography are frequently combined in the same work. Indeed it is scarcely possible to write any history of a nation, which shall not consist, in a great part, of narratives or notices of the acts of individuals. The life of every eminent political character, and of every person who has been conspicuously engaged in the conduct of any department of public affairs, makes a portion of the history of his country. But besides such occasional threads of biography as are interwoven in almost every historical composition, a more formal intermixture, or association in the same work, of biographical details with national history, has sometimes been attempted. Thus, for example, to his 'History of the Age of Louis XIV.' Voltaire has added a biographical appendix of the more celebrated writers, painters, musicians, sculptors, and other artists who lived in France during that period. So, in the very useful 'Synopsis of Universal History,' written in German by J. H. Zopf, of which there is an enlarged and otherwise improved translation into French (5 vols. 12mo. 1810), an account of the most eminent writers of every century is regularly added to the abridgment of political events. In most recent histories, the progress of literature is in a similar manner traced alongside of that of national affairs, in distinct chapters, containing accounts of the lives and writings of men of letters. There is indeed scarcely any other way than this of incorporating the history of literature with the history of political transactions; and it will therefore be more or less resorted to whenever the former subject is thought of sufficient importance to be included in the writer's scheme.

But biography has sometimes been intermixed with history on a more comprehensive principle. We have an example of this in one of the divisions of the 'Encyclopædia Metropolitana,' which is described in the plan of the work as containing "Biography chronologically arranged, interspersed with introductory chapters of National History, Political Geography, and Chronology." Here the history would appear to be subordinate to the biography. In the 'General Introduction' to the Encyclopædia, which was written by Mr. Coleridge, though much altered both by interpolation and otherwise after it left his hands, it is said, "Biography and history tend to the same points of general instruction, in two ways: the one exhibiting human principles and passions acting upon a large scale; the other showing them as they move in a smaller circle, but enabling us to trace the orbit which they describe with greater precision. . . . . Assuredly the great use of history is to acquaint us with the nature of man. This end is best answered by the most faithful portrait; but biography is a collection of portraits. At the same time there must be some mode of grouping and connecting the individuals, who are themselves the great landmarks in the map of human nature. It has therefore occurred to us that the most effectual mode of attaining the chief objects of historical knowledge will be to present history in the form of biography chronologically arranged. . . . . Thus will the far greater portion of history be conveyed, not only in its most interesting, but in its most philosophical and real form; while the remaining facts will be interwoven in the preliminary and connecting chapters." No work on this plan however making any pretension to completeness, or at all satisfactory in execution, has yet appeared: and the inconveniences attending it are too obvious to be overlooked.

Some of the most ancient literary compositions in existence are works of biography, or of mixed biography and history. In the historical books of the Old Testament the narrative of public events is everywhere intermixed with the lives of individuals—patriarchs, lawgivers, captains, high priests, judges, kings, and other rulers or eminent characters. In some cases the composition is purely biographical, as the Book of Ruth.

Of professed biographical works, by far the greatest that has come down to us from the Greeks, is the 'Parallel Lives' of Plutarch, written in the 2nd century of our æra. This work comprehends distinguished characters in all the departments both of military and civil life. Another collection of very small value is that of the 'Lives of Eminent Greek and Roman Commanders,' written by Cornelius Nepos, in the reign of Augustus. There is also the work entitled 'The Lives of the Twelve Cæsars' by Suetonius, which, however, is necessarily in some degree of an historical character. It is a very indigested composition, to whatever class it may be considered as belonging. Suetonius likewise wrote a book of lives of celebrated grammarians, of which some fragments have been preserved. "They who writ of philosophy," says Stanley, "exceeded the rest far in number, of whom to give a particular account will be unnecessary, because their works are not extant, and therefore we shall only name them: Aetius, Anaxilides, Antigonus, Antisthenes, Aristocles, Aristomenus, Callimachus, Clitomachus, Diocles, Diogenes Laërtius, Eunapius, Heraclides, Hermippus, Hesychius, Hippobotus, Ion, Idomeneus, Nicander, Nicias, Panætius, Porrius, Plutarch, Sotion, and Theodorus. Of almost all these (which is much to be deplored) there remain not any footsteps; the only author in this kind for the more ancient philosophers is Diogenes Laërtius; for the later, Eunapius. And to make the misfortune the greater, that which Laërtius gives us is so far short of what he might have done, that there is much more to be found of the same persons dispersed amongst other authors." Diogenes lived in the beginning of the 3rd century. At the end of the 2d and beginning of the 3rd century we have Flavius Philostratus, who wrote a collection of biographies in two books, entitled 'Lives of the Sophists.' Of single biographical sketches the ancients have also left us several, most of which seem to have been originally prefixed to editions of the works of the persons to whom they relate. Thus we have a Life of Homer attributed to Herodotus; and another of Plato, by Olympiodorus of Alexandria. Of all such single lives perhaps the most curious is that of Apollonius of Tyana, written in Greek by the Philostratus above-mentioned. An earlier life of Apollonius, which is now lost, is said to have been written by his disciple and contemporary Damis.

Since the revival of letters numerous biographical works have appeared in every language of Europe. Many of these have been accounts of the lives of single individuals, published either separately, or (in the case of authors) along with the works of the persons to whom they relate. In some cases the writer of such a life has aimed at making his work present a history, political, ecclesiastical, literary, or general, of the age to which its subject belonged. As answering a similar end, though written apparently with a less particular regard to the same object, may be mentioned one of the most amusing, and in some respects one of the most perfect, of all biographical works, Boswell's Life of Johnson. Others of these single lives are called autobiographies, or narratives which individuals have written of their own lives. A collection of the most celebrated autobiographies, which it is evident must in general have certain peculiarities strikingly distinguishing them from common biographical accounts, was published a few years ago in London by Messrs. Hunt and Clarke, in 34 vols. 18mo.

Cæsar's Commentaries of the Gallic and Civil Wars may be quoted as examples of autobiographical works in ancient literature. Another example is afforded by the lost history of his own times, also entitled Commentaries, written by the Greek General Aratus, which Polybius mentions. [ARATUS, BIOG. DIV.]

The collections of Lives that have appeared in modern times have also been very numerous. Thus we have the various martyrologies, or accounts of the lives and deaths of the early Christian martyrs, by Ruinart (fol. Amsterdam, 1713), by Assemani (2 vols. fol. Rom. 1748), &c. There is also the great work of the Flemish Jesuits, Bollandus, Henschenius, &c., entitled 'Acta Sanctorum Omnium,' which was begun to be published at Antwerp in 1643, and is of the enormous extent of fifty-three volumes folio. The 16 volumes quarto of Tillemont's work, entitled 'Mémoires pour servir à l'Histoire Ecclésiastique de vi. premières siecles de l'Eglise,' (Paris, 1693, &c.) is also in the main a work of ecclesiastical biography. There are also the Lives of the Fathers, by St. Jerome, and by many succeeding writers; the Lives of the Popes by Anastasius, commonly called the 'Bibliothecary,' and by others in later times; the Histories of the various monastic orders, which are all in the greater part biographical; and such works as John Fox's 'Book of Martyrs,' &c. As examples of collections of lives of the members of different artificial orders of persons among ourselves, may be noticed such works as Ashmole's 'History of the Order of the Garter,' the various Peerages and Baronetages; Wilson's 'Biographical Index to the House of Commons,' (Lond. 1806): Ward's 'Lives of the Professors of Gresham College,' Wood's 'Athenæ Oxonienses,' which is an account of writers educated at Oxford, &c.

The lives of eminent statesmen, military commanders, admirals, navigators, travellers, highwaymen, and various other descriptions of persons, either in all countries, or in some one country, have frequently formed the subjects of distinct works. Boccaccio wrote a work in Latin, first published at Ulm in 1473, in folio, entitled 'Opus de Claris Hominibus et Mulieribus,' and in subsequent editions, 'De Casibus Virorum et Feminarum Illustrium,' being a history of unfortunate princes and princesses, and other persons of eminence. A translation of this work into English verse, from a very paraphrastic French version executed by Laurent de Premierfait, was composed by John Lydgate, who lived in the reign of Henry VI., under the title of 'The Tragedies gathered by John Bochas of all such princes as fell from their estates through the mutability of fortune since the creation of Adam until his time.' The poem is commonly known by the title of Lydgate's 'Fall of Princes.' Somewhat similar to the design of this work, and indeed confessedly borrowed from it, is that of the celebrated collection of poems, first published in quarto, in 1559, with the title of 'A Mirror for Magistrates, wherein may be seen, by example of others,

with how grievous Plagues Vices are punished, and how frail and unstable worldly Prosperity is found, even of those whom Fortune seemeth most highly to favour.' But the narratives in the 'Mirror for Magistrates,' are all selected from English History, from which, as the editor in his dedication complains, Boccaccio had omitted to take any of his examples. A new edition of the 'Mirror for Magistrates,' which ranks so high in our old poetry, on account of the two admirable pieces which it contains,—the Induction and the Complaint of Henry Duke of Buckingham, by Thomas Sackville, the first Lord Buckhurst and first Earl of Dorset—appeared in 2 vols. 4to. in 1815, under the superintendence of the late Mr. Haslewood. Many biographical works have appeared, containing exclusively the lives of females. A collection of some of the earliest of these was published in a folio volume at Paris in 1521, under the title of 'Opera Diversorum aliquot Scriptorum de Claris Mulieribus ex editione Jo. Ravisii Textoris.' Two of the books of Brantome's Mémoires are occupied with gallant women (Dames Gallantes), and one with illustrious women. Menage wrote a work entitled 'Historia Mulierum Philosophorum.' There is a little book in French, called 'La Gallerie des Femmes Fortes,' by Pierre le Moyne, an edition of which, adorned with handsomely executed portraits, was published by the Elzevirs at Leyden, in 1660. There was published at Paris, in 3 vols. 12mo., in 1779, a 'Dictionnaire Historique Portatif des Femmes Célèbres.' Bayle (Dictionnaire, Art. 'Urraca,' note E.) complains that writers of lives usually select only persons of distinguished merit, and that of women especially who have been the disgrace of their sex and their country no biographical account as far as he knew had appeared. "Yet," he continues, "it is a subject which it would be well worth some writer's pains to handle. It might be treated after the fashion of Plutarch; I mean that as that famous author has chosen the most illustrious Romans, and the most illustrious Greeks, in order to draw parallels between them, the queens and princesses of different nations might in like manner be compared together."

The most numerous class of biographical works is that of collections of literary biography. Of these many of the most important are mentioned under the article BIBLIOGRAPHY. Among others which are not noticed there, we may mention such works as the 'Pulcher Tractatus de Vita Philosophorum,' by Walter Burley (the Venerable Doctor, as he was called), 4to. Colon. 1472, a very rare volume; the 'History of Philosophy, containing the Lives, Opinions, Actions, and Discourses of the Philosophers of every sect,' by Thomas Stanley, which appeared in four successive volumes in 1655, 1656, 1660, and 1662, and has since been translated into Latin, as well as several times reprinted in English; the 'Historia Critica Philosophiæ' of Brucker, 5 vols, 4to. Leipzig, 1741-4, and second edition, 6 vols. 4to. 1767; the 'Theatrum Virorum Eruditione Clarorum' of Paul Freher, 2 vols. fol. Noriberg, 1688; the 'Vitæ Virorum Eruditorum' of Melchior Adam, 2 vols. fol. Francf. ad Moen. 1705; the 'Mémoires pour servir à l'Histoire des Hommes Illustres dans la République des Lettres,' of J. P. Niceron, 42 vols. 12mo. Paris, 1729-45; the 'Lives and Characters of the English Dramatic Poets,' by Gerard Langbaine, 8vo. Lon. 1698; the 'Biographia Dramatica' of D. E. Baker, first published in 1764, the best edition of which is that published by the late Mr. Isaac Reed, in 2 vols. 8vo. in 1782; the 'Lives of the English Poets,' by Dr. Johnson, &c.; the 'Biographia Britannica Literaria,' Anglo-Saxon and Anglo-Norman periods, by Thomas Wright, published by the Royal Society of Literature, 8vo, 1842. Almost more numerous perhaps have been the collections of biographies of artists; as examples of which may be mentioned Vasari's 'Lives of the most eminent Painters, Sculptors, and Architects,' first published at Florence in 2 vols. 4to. in 1550, and repeatedly since with many additions; Sandrart's 'L'Academia Todesca; Teutsche Academie der edlen Bau- Bild- und Mahlerey Künste,' 4 vols. fol., Nürnberg, 1675-79, better known by the Latin translation, 'Academia Noblissimæ Artis Pictoriæ,' Nürnb. 1783; 'True Effegies of the most eminent Painters and other famous Artists that have flourished in Europe,' sm. folio, Lond. 1694 (with 120 portraits, originally published at Antwerp in 1649); Pascoli's 'Vite de' Pittori, Scultori, ed Architetti Moderni,' Rome, 1736; the Dictionary of Artists of Pelegrino Antonio Orlandi, first published at Bologna in 4to. in 1719, under the title of 'Abecedario Pittorico;' J. B. Descamp's 'La Vie des Peintres Flamands, Allemands, et Hollandois,' 4 vols. 8vo. Par. 1753-64; D'Argenville's 'Abrégé de la Vie des plus fameux Peintres,' 4 vols. 8vo. Paris, 1762; Hüber, 'Notices générales des Graveurs divisés par Nations, et des Peintres rangés par Écoles,' &c. 8vo. Dresden, 1787; Lanzi's, 'Storia Pittorica,' of which the first part appeared in 1790, the last in 1796, but which he afterwards considerably extended in subsequent editions; Horace Walpole's 'Anecdotes of Painting in England and Catalogue of Engravers,' forming in all 4 vols. 4to. 1761-1771; Pilkington's 'Dictionary of Painters,' 4to. 1770, and 2 vols. 8vo. 1829; 'Lives of the most eminent British Painters, Sculptors, and Architects,' by Allan Cunningham, 6 vols. 12mo. 1829-33; the great work of Nagler, 'Neues allgemeines Künstler-Lexicon, oder Nachrichten von dem Leben und den Werken der Maler, Bildhauer, Baumeister, Kupferstecher, Formschneider, Lithographen, Zeichner, Medailleure, Elfenbeinarbeiter, &c.,' 22 vols. 8vo. München, 1835-51; Stirling's 'Annals of the Artists of Spain,' 3 vols. 8vo. 1848; and many other works of a similar description.

Of the principal collections of exclusively British biography an account is given in the preface to the first edition of the 'Biographia Britannica.' The writer mentions the 'Catalogus Scriptorum Ecclesiæ,' composed by John Boston, a Benedictine monk of St. Edmondsbury, in the reign of Henry IV. (which was never published, and of which there are but few manuscript copies extant); the 'Commentarii de Scriptoribus Britannicis' of John Leland, prepared in the reign of Henry VIII., but first published at Oxford in 2 vols, 8vo. in 1709; John Bale's 'Scriptorum Illustrium Majoris Britanniæ Catalogus,' the first part of which was published at Ipswich, and the same year at Wesel, in 4to. in 1549: the first complete edition appeared at Basel in the same form in 1557; the treatise entitled 'De Academiis et Illustribus Angliæ Scriptoribus,' by John Pits, the first volume of which (the only one that was ever given to the world) was published in 4to. at Paris in 1619; the 'Historia Ecclesiastica Gentis Scotorum' of Thomas Dempster, 4to. Bonon. 1627, and of which a new edition was printed a few years ago by the Bannatyne Club of Edinburgh, a work of no authority, or rather indeed a mere romance; Sir James Ware's work, 'De Scriptoribus Hiberniæ,' 4to. Dublin, 1639, also translated into English, with a continuation, in the editions of his collected works published in 1739 and in 1764; and Fuller's 'Worthies of England,' folio, 1662. The first edition of the 'Biographia Britannica, or the Lives of the most eminent persons who have flourished in Great Britain and Ireland from the earliest ages to the present times,' was begun to be published at London in 1747, and was completed in 5 vols. folio, in 1766. Most of the best articles in this work were written by Dr. John Campbell, the author of the 'Political Survey of Great Britain;' among the other writers were the Rev. Thomas Broughton, William Oldys, and Philip Morant, author of the 'History of Essex.' A new and much extended edition of the 'Biographia Britannica' was begun in 1778 by the late Dr. Andrew Kippis, but was not carried farther than the fifth volume (folio), which brings down the alphabetical list of names only to the letter F. This edition, besides a great mass of new matter collected by the laborious editor, is enriched by communications from Lord Hailes, Lord Hardwicke (the author of the 'Athenian Letters'); Dr. Percy, Bishop of Dromore; Dr. Douglas, Bishop of Salisbury; Sir William Blackstone, Isaac Reed, and several other eminent literary persons of that time. Perhaps the most important body of British biography that has issued from the press, since the publication of the 'Biographia Britannica,' is the work of the late Mr. John Nichols, entitled 'Literary Anecdotes of the Eighteenth Century,' 9 vols. 8vo. Lond. 1812-16, with the supplement entitled 'Illustrations of the Literature of the Eighteenth Century,' 5 vols. 8vo. 1817-28. Another work of considerable value in this department is that entitled 'Portraits of Illustrious Personages of Great Britain, with Biographical and Historical Memoirs' by Edmund Lodge, Esq., 12 vols. 8vo. Lon. 1823-35. This last-mentioned work is on a somewhat similar plan to the 'Heads of Illustrious Persons of Great Britain,' engraved by Houbraken and Vertue, with memoirs by Dr. Birch, which appeared in 2 vols. fol. in 1752. Mr. Grainger's 'Biographical History of England,' originally appeared in 2 vols. 4to. in 1769, and was afterwards extended by the author to four 8vo volumes. A continuation of Mr. Grainger's work, in 3 vols. 8vo., by the Rev. Mark Noble, appeared in 1806. The 'Gallery of Portraits, with Memoirs,' completed in 1837, in 7 vols. imp. 8vo., contains a selection of 129 of the most eminent individuals of all countries, of whom the memoirs have been written with great care and ability.

Of general biographical dictionaries, the 'Dictionarium Historico-Geographico-Poeticum,' of Charles Stephens, published in 4to. at Geneva, in 1566, two years after the death of the author, may probably be regarded as the earliest; but this work, as its title indicates, contained many others besides biographical articles. The same remark applies to the 'Dictionarium Historicum, Geographicum, Poeticum, Gentium, Hominum, &c.,' of our countryman, Nicholas Lloyd, which appeared in folio, first at Oxford in 1670, and again, greatly enlarged, at London in 1686. A much more extended work, of a similar description, is the 'Lexicon Universale Historico-Geographico-Chronologico-Poetico-Philologicum,' of Jo. Jac. Hofman; the first edition of which, in 2 vols. folio, was printed at Bâle in 1677. A Supplement, or 'Continuation,' as it is called, of the same extent, followed in 1683; and, finally, the two publications were incorporated in a new edition published at Leyden in 4 vols. folio, in 1698. Hofman's work may be considered as the origin of our modern encyclopædias. Our exclusively biographical dictionaries may be regarded as having been rather suggested by another work which appeared about the same time, 'Le Grand Dictionnaire Historique et Critique,' of Louis Moreri. This work, the first edition of which appeared in 1 vol. folio, in 1673, although its contents were also very miscellaneous, was still of a more decidedly biographical character than that of Hofman. Of Moreri's Dictionary there have been about twenty editions in French, the last of which appeared at Paris in 1759, in 10 vols. folio. Upon Moreri's Dictionary was founded the 'Great Historical, Geographical, Genealogical, and Poetical Dictionary,' printed at London in 1694: the second edition of which, 'revised, corrected, and enlarged to the year 1688, by Jeremy Collier, A.M.,' appeared in 2 vols. folio, in 1701. To these a third volume was added in 1705, containing a Supplement by Collier, and, in a separate alphabet, 'a Continuation from the year 1688 to this time, by another hand.' The whole was afterwards republished, with additions, in 4 vols. folio, in 1727. Meanwhile the immortal 'Dictionnaire Historique et Critique' of Bayle, originally

undertaken with the view of supplying the deficiencies and correcting the errors of Moreri, but which, in the course of preparation, soon assumed the form and character of an independent work, appeared in 2 vols. folio, at Rotterdam, in 1697. A second edition, enlarged to 3 vols., followed in 1702; and a third in 1722, after the death of the author, at Geneva, in 4 vols., the last being a supplementary volume consisting of additional articles which he had left ready for the press. The best of the old editions of Bayle is the fourth, published at Rotterdam in 4 vols. folio, in 1720, under the superintendence of Prosper Marchant, and often called the 'Regent edition,' from being dedicated to the Regent of France, Philip, Duke of Orleans; but an edition in 17 vols. 8vo., recently appeared at Paris, which, from the annotations it contains in correction of the original text, is now the most complete and valuable. Bayle's Dictionary, though it contains only a selection of names, is almost exclusively biographical. A very indifferent translation of it into English was published soon after the appearance of the original; but one much better executed was produced some years after by Peter Des Maizeaux, in 5 vols. folio, London, 1734-7. To Bayle's Dictionary should be added the Supplement to it by Chaufepié, published in 4 vols. folio, Amsterdam, 1750. The valuable 'Dictionary of Greek and Roman Biography and Mythology,' edited by Dr. W. Smith, 3 vols. 8vo, 1844-49, may also be mentioned here.

The first 'English General (exclusively) Biographical Dictionary' appeared in 1762, in 11 vols. 8vo. "It is understood" (says the writer of an article 'On Universal Biographies' in the 'London Magazine,' No. XII. third series) "to have been projected and principally written by the Rev. Dr. Heathcote, who, assisted by the late Mr. Nichols, brought out a second edition of the work in 12 vols. in 1784. A third edition in 15 vols. appeared in 1798, under the superintendence of Mr. Tooke, the author of the 'History of Russia.' It is the last edition of this work which goes by the name of Chalmers's 'Biographical Dictionary,' which, having been begun to be published in 1812, was completed in 1817, in 32 vols. 8vo. Chalmers's 'Dictionary' is merely a hurried and tasteless compilation, and without any pretensions to be regarded as an authority. It is a better book, however, than the 'General Biographical Dictionary' of Drs. Aikin and Enfield, in 10 vols. 4to., begun in 1799, and finished in 1815. Of smaller English works of this description there have been several, but none of much merit: the best perhaps is that by the late Mr. John Gorton, published in 2 vols. 8vo. in 1828. The most exhaustive attempt at a 'Biographical Dictionary' was made by the Society for the Diffusion of Useful Knowledge in 1842, but it was discontinued in 1844, when only the letter A was completed. That portion occupied seven 8vo. volumes, each volume containing considerably more than one of the 'Biographie Universelle.' In this the names of the contributors of the articles were given. Another 'Biographical Dictionary' is that of H. J. Rose, in 12 vols. 8vo., of which a second edition was published in 1848. The 'Biographical Division of the English Cyclopædia' is more than equal to any of the foregoing in extent, and has the advantage over them of containing memoirs of living personages.

Of foreign biographical works the most remarkable was the great French work, the 'Biographie Universelle,' begun in 1810, and completed in 52 vols. 8vo. in 1828. To every article in this work the name of the writer is affixed; and the list of contributors, who are in all considerably above 300 in number, comprises the names of Biot, Delambre, Lacroix, Malte-Brun, Walckenaer, Sylvestre de Sacy, Sismondi, De Barante, Guizot, Cuvier, Victor Cousin, Chateaubriand, Benjamin Constant, Laplace, Madame de Stael, Delille, and many other of the then most eminent living French writers. This work has been reprinted with additions. A new general biographical dictionary begun in 1852, is now (1859) in course of publication, under the title of 'Nouvelle Biographie Générale,' and is a work of considerable merit. In French there are also the 'Biographie des Hommes Vivantes,' in 5 vols. 8vo.; and the 'Biographie Nouvelle des Contemporains,' in 20 vols., neither of which is of any great authority. A very remarkable and important oriental biographical and bibliographical dictionary is the 'Lexicon Encyclopædicum et Bibliographicum' of Haji Khalfa, in 7 vols. 4to, Leipzig, 1835-59. It is in Arabic and Latin, and has been edited by Professor G. Flügel at the cost of the Oriental Translation Fund of the Royal Asiatic Society, and is stated in the society's report for 1859, to have cost the society nearly 4000*l.*, and Prof. Flügel nearly twenty-five years of labour.

In Germany, the various editions of the 'Conversations Lexikon,' contain a large body of biography, on the whole executed with great care and correctness.

BIQUADRATIC, an algebraic term, meaning of the fourth degree, or which contains the fourth power of any letter. Thus, to find the value of x in

$$x^4 + 3x^2 = x + 100$$

is the solution of a biquadratic equation.

The term means "twice as high as a quadratic." [QUADRATIC.] Among the older algebraists, the fourth power was also denoted by the terms *quadrato-quadratum*, *plano-planum*, *suesolidum*, *zenzizensic* (corruption of an Arabic word), &c. The word *biquadratic* wore out of use, and it became customary to say "of the fourth degree" instead. It is now proposed to say *quartic* instead of biquadratic, and to call an expression of some definite algebraical degree a *quantic*. We think the proposal a very good one.

BIRCH; ECONOMICAL USES. The birch is extremely valuable among our forest trees, from the variety of materials which it furnishes to the manufacturing arts. The timber, without possessing any one quality in an eminent degree, possesses many qualities in moderate extent. It is employed in France for the felloes of wheels, and in Russia for the construction of small rustic carriages. On many parts of the Continent it is used for divers articles of furniture, cooperage, and turnery, and for sabots or wooden shoes. The Highlanders of Scotland use birch for so many purposes that they are said to "make everything of it:" they frequently build their houses of it; make their chairs, tables, dishes, and spoons of it; construct their mills of it; make their carts, ploughs, barrows, gates, and fences of it; and even manufacture ropes of it. The above uses apply to the *white* birch. The *black* or *canoe* birch is also of great value; it flourishes in North America, and is there applied to numerous purposes. Some specimens of this timber are so beautifully grained that they are cut into veneers and used in cabinet work. The wood of the *tall* or *American* birch is used in the United States and Nova Scotia for yokes of cattle and frames of sledges, for hoops of casks, for articles of furniture, and for many other purposes. The wood of the *pliant* birch has a fine and close grain, and a considerable degree of strength, and takes a brilliant polish. It is used in the United States for tables, bedsteads, arm-chairs, sofas, coach-panels, shoe-lasts, and a great variety of purposes.

The *bark* of all the species of birch is of considerable value, especially in cold northern countries, where it is applied to a great variety of uses. It is very durable, and little acted on by air or water. In some countries it is used as a coping for walls and a covering for roofs. The bark of large trees is cut by the Laplanders into pieces large enough to form capes or short cloaks. It is also employed for boots, shoes, baskets, boxes, mats, cordage, harness, and thread. In Kamtschatka the inner bark is dried and ground, and mixed with oatmeal to form an article of food; and the same people eat the bark in small pieces with the roe of fish. It is much used for tanning leather; and a yellowish-brown dye which it yields is employed in some countries for dyeing woollens and rein-deer skins. The bark of the *canoe* birch is used in America for roof coverings, baskets, boxes, portfolios, paper, and inner soles of shoes; but it is more extensively employed in making the canoes of the *voyageurs* engaged in the fur trade of Canada: such a canoe, capable of accommodating four persons, will weigh no more than 40 lbs. Tents are also made of this bark. The bark of the *tall* birch is used in tanning; that of the *pliant* birch is stripped while in the green state by the Kamtchatkadales, cut into narrow strips like vermicelli, and stewed with caviare.

The *branches* and young *shoots* are also of much value. They are made into hoops, brooms, faggot-ties, baskets, hurdles, cream-whisks, and similar articles, including the well-known rod of our old-fashioned schoolmasters. The Alpine mountaineers make torches of them. The Laplanders construct tents with birch branches covered with turf. In the Scottish Highlands the branches are employed as fuel in the distillation of whiskey, being found (or at least reputed) to impart a flavour to it which enhances its value. They are similarly employed for smoking hams and herrings. The young branches of the *dwarf* birch furnish beds and fuel to the Laplanders; and those of the *black* birch are employed in the United States for making hoops for rice-casks.

The *leaves*, *catkins*, and other green parts, have also their value. The leaves are eaten by goats and rabbits. A yellow colour is obtained from them, useful in painting and dyeing. The Finlanders use the dried leaves as tea. The buds and catkins afford a substitute for bees' wax. A bed stuffed with birch leaves is said to be useful to rheumatic persons by promoting perspiration. The leaves of the dwarf birch yield a peculiar kind of fungus, from which the substance called *moxa* or *amadou* is prepared, and which the Laplanders employ as a medicine in many painful diseases; and its seeds afford nourishment to the ptarmigan, or white partridge, a very important bird in Lapland.

The *sap* of the birch is made to yield beer, wine, spirit, vinegar, and sugar, according to the mode of treatment; the tree being tapped to allow the sap to flow or ooze out. Birch beer is made by fermenting the sap with yeast, hot water, and hops. Birch wine is made by boiling the sap with sugar or honey, and fermenting, clarifying, and flavouring in various ways. Birch spirit is made by distillation; birch vinegar, by allowing the acetous fermentation to supervene on the vinous; and birch sugar, by boiling and evaporating the sap.

To complete the catalogue of the use of the birch, we have to mention the *fuel*, the *ashes*, and the *oil*. The wood gives a bright and ardent flame, and is much employed for smelting iron in France, Russia, and Sweden; its charcoal burns a long time, and is in much demand for making gunpowder and black crayons. The ashes are rich in potash. An oil, much used in Russia, is obtained by burning birch bark in close receptacles.

BIRDLIME. When the middle bark of the holly is boiled for several hours with water, and then placed in a moist situation, as under moist earth, it enters into fermentation and becomes a viscid mass, from which birdlime may be prepared by bruising, washing, and kneading it to remove extraneous matters, and lastly leaving it again to ferment in earthen vessels. It may also be made from mistletoe and other plants. Birdlime owes its peculiar property to the presence

of a peculiar substance termed *viscin*, which may be obtained in a purer form by repeatedly digesting the berries of the mistletoe in ether, and finally expelling the ether at a gentle heat. Viscin is a white, tough, opaque, and very adhesive resin, which does not dry. It is soluble in ether, essential oils, and solution of potash, but insoluble in alcohol and dilute acids. Nitric acid converts it into oxalic acid and a solid fat. Macaire-Prinsep found it to consist of

Carbon	75·6
Hydrogen	9·2
Oxygen	15·2
	100·0

The same chemist believes birdlime to be a mixture of viscin, bassorin, and acetic acid, and that it does not exist in the plants from which it is procured, but is produced by fermentation. The viscosity and toughness of viscin are so great, that when small birds alight upon branches smeared with it, they cannot extricate themselves; hence the use of the impure substance by bird catchers.

BIRD'S-EYE VIEW, a mode of perspective representation, which may be divided into two kinds, *proper* and *improper*. The latter of these, the one most generally employed, differs from ordinary perspective delineation, in nothing else than in the horizon being taken much higher than usual: the horizontal line, and of course the point of sight, is either placed above the picture, or the level of the ground is supposed to be considerably below the base of the picture. The objects thus shown, whether buildings or landscape, or both combined, appear as they would do if viewed from some lofty station, from the summit of a building, from a terrace, tower, or any other eminence; but still the spectator is supposed to be looking in a straightforward direction, and the plane of the picture to be perpendicular to the natural horizon. Consequently, only distant objects can thus be shown, because, when looking in that direction, a person cannot possibly see objects immediately beneath him. He can do that only by looking *down upon* them; but in a picture there can be but one *instant* of view, nor can the point of sight be shifted at pleasure, by the eye being directed upwards or downwards, so as to alter the field of vision, and take different objects in succession. Whatever is shown in a picture must be supposed capable of being embraced by the eye at once; although in practice some slight degree of licence in this respect is occasionally allowable.

If it be desired to show the objects immediately below the spectator, so as to give a distant view of the tops of buildings so situated, and of parts that would otherwise be concealed from sight, recourse must be had to the first-mentioned mode, namely *proper bird's-eye* perspective. This is the reverse of that employed for ceiling-pieces, termed *di sotto in su*; for as there objects are fore-shortened as seen from below, so in the *bird's-eye* they are foreshortened, as if viewed from above. This species of *bird's-eye* might therefore with great propriety be distinguished by the name of *prone perspective*, or looking downwards; and the *di sotto in su*, by that of *supine perspective*, or looking upwards. In like manner as in ceiling perspectives, the plane of the picture becomes parallel to the natural horizon, instead of vertical, so does it in a proper *bird's-eye* view; with this difference, that in the former case the eye is beneath the picture and looking up to it; in the latter over it, and looking down upon it; at least, if not exactly horizontal, the plane of the picture must be more or less inclined, according as the eye is supposed to look down more directly or obliquely; because the *plane of projection* or picture must be assumed as perpendicular to the central ray from the eye. The relative position of objects to each other and to the picture, and of the picture to the eye, are the same in this as in ordinary perspective, the sole difference being that of the spectator's own situation. This will be apparent if we look into a hollow cube, or box, open on one side; it matters not whether it be open on one of the upright sides, or on the top. In either case the planes or sides perpendicular to the open side, and the one parallel to, or facing it, will have the same perspective appearance; only in the one case the plane facing the spectator will be vertical, in the other horizontal. In a picture or drawing this will depend entirely upon the artist—whether he chooses to represent the plane parallel to the picture as horizontal, that is the ground or floor, and the other planes perpendicular to the ground; or that parallel plane and two of the adjoining planes upright, and the other two horizontal. Again, were a hole bored through the ceiling of a lofty room, a person looking down through it would have a perfect or proper bird's-eye view, both of the apartment and its furniture. Hence, it is obvious that in such representation the floor would answer to what in the common mode of perspective would be the side or end of the room facing the spectator; also that the vertical lines of the sides of the room, of doors, windows, legs of chairs, &c., would vanish to some point in the line or plane passing through the eye, exactly as the horizontal lines would do if they were seen according to the usual position. For unless the lines, in this case intended to represent upright ones, were made to vanish, those planes or walls would not be foreshortened; and unless that were done they could not be viewed, but the whole would be reduced to a mere plan of the room; just as a common upright view would be reduced to a section or geometrical elevation, if the planes representing the other two walls with the ceiling and floor were not shown perspectively or foreshortened. Yet, although such perspective or bird's-eye view would be correct in itself, it would seem too fanciful and unnatural, if not positively distorted, because the objects would be shown under such very different circumstances from those according to which they are really seen; consequently, such kind of views would be quite unpictorial, and merely matters of curiosity. They might, indeed, occasionally be found useful as explanatory diagrams, or drawings, whenever it should be required to show the effect of an interior, as beheld from a lofty upper gallery, not viewed in a cross or straightforward direction, but by looking down into the lower area of the apartment. This *prone perspective* might also be applied for the purpose of giving a map-like, yet graphic view of a group of buildings and their locality. As a picture, however, such view would be extravagant, although as a picture-map it would have something to recommend it. Even the more usual kind of bird's-eye perspective, or view with a very elevated horizon, is by no means well calculated for picturesque effect, since it brings those parts of an edifice into view which are intended to be concealed, and otherwise greatly takes off from the architectural effect; causing the building so viewed to appear too much like a small model placed upon a table.

BIRDSMOUTH. [MOULDING.]

BIRTH. [INFANTICIDE.]

BISCUIT, in pottery, is a term used to denote porcelain as well as the commoner kinds of earthenware at a certain stage of the manufacturing process. To render them fit for most purposes, it is necessary that fictile wares should be covered with a vitreous glaze; and hence arises the necessity for subjecting them twice to the action of heat in furnaces. The first baking is necessary in order to preserve the shape and texture of the pieces; seeing that they would otherwise be altered in these respects through the absorption of the water from the glaze, which must be used in a fluid form. Neither would it be possible, for the same reason, to apply painting, or to transfer printed patterns to their surfaces in the green state—that is, previously to firing. It is after this first baking, and previous to the application of the glaze and of embellishments, that these wares receive the name of biscuit, which is given from the resemblance which they bear in colour and apparent texture to ship-bread. Strictly speaking, the name is a misnomer, seeing that these articles are not 'twice-baked' while in their biscuit state. The second firing is necessary in order to vitrify the glaze, and to bring out the metallic colours which are used for embellishing earthenwares.

The heat of the first oven must be *at least* equal to that employed for the vitrification of the glaze; because, as soon as that degree of heat to which earthenwares have been already subjected is passed, a further degree of shrinking occurs, which would occasion the glaze to crack and peel off—an effect which will not be produced by a repetition of the degree of heat that has been once applied. It is a property of clay to contract when subjected to any degree of heat greater than it has previously borne, but short of the point of fusion; and it is another property to continue at that same state of contraction at every other temperature which is not above the degree of heat to which it has once been subjected, and by which its actual state of contraction has been produced.

Earthenware in the state of biscuit is permeable to water, which however it imbibes without undergoing any alteration of texture. This quality fits it for being used in the cooling of fluids, which effect is produced through the rapid evaporation from the outer surface.

See further on this subject under POTTERY and PORCELAIN.

Many beautiful statuettes have been produced in the Staffordshire potteries during the last few years, from models by Bell and other sculptors, in materials more or less resembling biscuit-ware.

BISCUIT-MANUFACTURE. Biscuit (German, *Zweiback*; Dutch, *Scheepsbeschait*; Danish, *Skibstvebak*; Swedish, *Skeppsbrod*; French, *Biscuit*; Italian, *Biscotto, Galetta*; Spanish, *Bizcocho, Galleta*; Portuguese, *Biscoito*; Russ, *Bort, Ssucher*; Latin, *Panis Biscortus Nauticus*), a kind of bread made usually in the form of flat cakes. This form is given to biscuits to insure their being deprived of moisture in the baking, which circumstance is necessary for preserving them fit for use during the continuance of long voyages. The use of this kind of bread on land is indeed pretty general as a matter of luxury; but at sea, biscuits are an article of the first necessity, seeing that bread, in the more ordinary form in which it is used on shore, would speedily become mouldy and unfit for food.

The name biscuit ('twice-baked') is evidently derived from the nature of the processes to which this kind of bread was formerly subjected. The two bakings then used are no longer found necessary; but the name, although thus rendered inappropriate, has been continued.

We may confine our notice chiefly to that kind of biscuit which forms a principal part of the food of seamen, and which is for that reason usually known as ship-bread or biscuit. When intended for this use, biscuits are most commonly made of the meal of wheat from which only the coarsest bran has been separated. It is hardly possible to be too particular in the selection of meal for this purpose; since any damage to which it may have been subject, either before or after being ground, would prevent biscuits, however carefully made, from keeping sound for any length of time. The preparation of sea-biscuit is carried on as a substantive branch of business in almost every port of resort for vessels engaged in trading with distant countries.

The largest biscuit-manufactories are those maintained by government for supplying the navy. The scale upon which these are carried on is such as to make it of great importance to introduce into the process

every simplicity compatible with the goodness of the articles; and improvements have, with this view, been made from time to time to lessen the amount of labour in the establishments. The mode of conducting the operations, on what may be termed the hand-method, is as follows :—

Meal and water being mixed together in due proportion, the dough is placed upon a wooden platform. A wooden roller, or staff, has one end fixed by means of a staple and eye to the wall, so that the roller can be made to traverse the surface of the platform; and when the dough is placed upon it, the roller is used to knead it by indenting upon it lines radiating in a semicircle from the staple. To perform this kneading process, a man seats himself upon the overhanging end of the roller, and proceeds with a riding motion backwards and forwards through the semicircular range until the dough is sufficiently kneaded; it is a very uncouth process, in which muscular labour is wastefully applied. In this kneaded state the dough is cut by large knives into slices, which are subdivided into small lumps, each sufficient for making a biscuit. In moulding these small lumps, which is done by hand, the dough undergoes a further degree of kneading, and at length receives the form of the biscuit. The men who thus fashion the dough make two of these cakes at the same time, working with each hand independently of the other. When this part of the work is completed, the two pieces which have been simultaneously prepared are placed one on the other and handed over to another workman, by whom the two together are stamped with a toothed instrument, the use of which is to allow the equable dissipation of moisture through the holes from all parts of the biscuit during the baking. The biscuits are then separated by another workman, who places them on a particular spot of a small table standing close to the mouth of the oven, so that each biscuit can be taken up in its turn without the necessity of his looking for it, by the man who supplies the oven. The office performed by this man is that of throwing the biscuits in succession upon the peel, which is held by another man whose business is to arrange them in the oven. This peel is a flat thin board, a few inches square, which can, by means of a long handle, be slidden over the floor of the oven, so as to deposit and arrange the biscuits thereon. The greatest nicety is required on the part of the man who thus throws the biscuits on the peel, and he could not perform this evolution with the necessary degree of precision if he were at any time obliged to withdraw his eye from the peel in search of the biscuit. The oven is by these means supplied at the rate of seventy biscuits in one minute. The mouth of the oven is necessarily open during the time of its being charged; the heat is therefore greater at the beginning than at the end of that operation; and besides this, the biscuits first deposited are of course a longer time exposed to heat than the rest. To remedy the irregularity that might be thus occasioned, the pieces of dough are gradually and regularly made of smaller bulk, so that the effect of the cooler oven is equalised by the smallness of the biscuits. When sufficiently baked, the biscuits are placed in the warm atmosphere of rooms well-ventilated over the ovens, and remain there until perfectly dry. In this state it is found that one hundred and two pounds of biscuits are procured from one hundred and twelve pounds of meal.

Notwithstanding the perfection to which the hand-method has attained, the processes have of late years been still further perfected and facilitated by the introduction of machinery. In the Royal Dockyards, the dough is thoroughly mixed and rolled out into sheets about two yards long and one wide, which are stamped at one stroke into about sixty hexagonal biscuits of six to the pound,—in such a manner as to leave the sheet sufficiently coherent to be put into the oven as one piece, though when baked the biscuits are easily separated. The hexagonal shape has been substituted for the circular, because it effects a saving of time and material, and also of space in packing.

At the ship biscuit bakery of Mr. Harrison, at Liverpool, an apparatus has been constructed which exceeds in automatic completeness even that employed at the government establishments; for the made biscuits travel into the oven without the aid of any *peel* or other hand-*worked tool*. The flour and water are placed in a cylinder, mixed well together by revolving bars, kneaded by a large iron cylinder, and spread like a large sheet on an endless cloth. As this cloth travels along, a nicely adjusted piece of mechanism cuts the dough into the shape of six-sided biscuits, and stamps them. Passing along the endless cloth, the biscuits are received by a kind of gridiron, and enter the oven. This oven is 26 feet long; it is heated by hot water, and bakes the biscuits as they slowly travel through it. The mechanism was patented by Mr. Harrison, in 1849.

Mr. Deucale, an American inventor, has introduced an ingenious mode of baking biscuits. A brick oven, 12 feet long, 6 wide, and 4 high, stands in the middle of the bakehouse. The top has no opening whatever. The front has an opening near the ground, with a metal door, through which the fuel is introduced, and made to cover the entire area of the floor of the oven. About a foot above the furnace door is an opening, six or eight inches high, and the whole width of the oven; and a similar opening exists at the back. Near each opening is a wooden cylinder; around both cylinders a wire lattice-work is tightly coiled, so as to form an endless cloth stretching horizontally within and across the oven, over the fire. The biscuits, in the state of dough, being ranged in a row along the front edge of the wire-cloth, the baker turns a winch-handle, and winds them into the oven; this he does row after row, until, by the time the first row has reached the back of the oven, the biscuits in that row are properly baked.

In another biscuit-baking apparatus, by Messrs. Barrett & Exhall, the flour is put into a receptacle, where it is speedily mixed into dough. This dough passes to a breaking machine, where it is kneaded until it becomes sufficiently tenacious to be passed between rollers for more thorough kneading. From these rollers it passes to other rollers, which reduce it to the required thickness. It then passes in a continuous sheet, by means of an endless web of canvas, to another machine, where it is cut, docked, crimped, and stamped. The biscuits are then divided from the waste dough, and conveyed to the oven. The waste dough is collected and passed through a shoot, to be re-kneaded, and made into biscuits.

It may here be remarked, in reference to navy biscuits, that an important national saving is effected by the use of machinery in the manufacture. Twenty years ago, it was calculated that the three government biscuit-bakeries at Deptford, Gosport, and Plymouth, could produce 7300 *tons* of biscuit in a year; that this quantity would cost 3200*l.* for labour, and wear and tear of machinery; that the wages and utensils on the old method would have cost 11,600*l.*; and that the nation thus saved 8400*l.* by employing machinery.

BISCUITS, MEAT. The meat-biscuits, which first became familiarly known in this country about the time of the Great Exhibition in 1851, are a kind of antiseptic or preserved food, introduced by Mr. Borden of America. As carried on at Galveston, in Texas (where excellent cattle abound at a very low price), the manufacture is so conducted as to concentrate the nutriment of the meat with flour, into a sort of biscuit. The biscuits are dry, inodorous, flat, brittle cakes, which will preserve their qualities for a (practically) unlimited period. No fat of beef is included; only the nutritive part of the lean. One pound of biscuit contains half a pound of wheaten flour combined with the nutriment from five pounds of beef. During the United States' war with Mexico these biscuits were taken as part of the army rations, packed in casks. When required for use, the biscuits are dissolved in water, boiled, and seasoned at pleasure, forming a soup about the consistency of sago. One ounce of biscuit will suffice for a pint of water. It can also be used as an ingredient in puddings and sauces. These meat-biscuits have not been brought much into use in England; yet Dr. Lindley, as a member of one of the juries of the Great Exhibition of 1851, spoke highly of them. He said: "I think I am justified in looking upon it as one of the most important substances which this Exhibition has brought to our knowledge. When we consider that by this method, in such places as Buenos Ayres, animals which are there of little or no value, instead of being destroyed, as they often are, for their bones, may be boiled down and mixed with the flour which all such countries produce, and so converted into a substance of such durability that it may be preserved with the greatest ease, and sent to distant countries: it seems as if a new means of subsistence was actually offered to us. Take the Argentine Republic, take Australia, and consider what they do with their meat there in times of drought, when they cannot get rid of it while it is fresh; they may boil it down, and mix the essence with flour,—and we know they have the finest in the world—and so prepare a substance that can be preserved for times when food is not so plentiful, or sent to countries where it is always more difficult to procure food. Is not this a very great gain?"

Professor Owen, as one of the jurors at the Paris Exhibition in 1855, noticed a kind of meat-biscuit which had been recently introduced in France by M. Beurmann. According to the information obtained, these meat-biscuits are thus prepared. Quarters of beef, immersed in water sufficient to cover them, are subjected to a long and slow ebullition. The liquid, after the fat has been skimmed off, is evaporated to the consistence of syrup; it is then incorporated with fine wheaten flour, in quantity sufficient to give it a consistence capable of yielding to the rolling-pin. When rolled out to the thickness of an ordinary ship biscuit, the cake is pricked and cut into the angular form best adapted for stowage. The meat-biscuits are then baked in an oven, thoroughly dried, and packed for exportation. They can be eaten in the dry state, like ordinary biscuits; and this confers great value on them for the soldier when in the trench or on the march. But they afford a more sapid and comforting kind of subsistence if they are broken up in about twenty times their weight of water, and boiled for half an hour with salt, or other condiments; an excellent and most nutritious soup is thus readily obtained.

See further on the subject of preserved meats under ANTISEPTICS.

BISHOP, the name of that superior order of pastors or ministers in the Christian church who exercise superintendency over the ordinary pastors within a certain district, called their see or diocese, and to whom also belongs the performance of those higher duties of Christian pastors, ordination, consecration (or dedication to religious purposes) of persons or places, and finally, excommunication.

The word itself is corrupted Greek. Ἐπίσκοπος (*epíscopos*) became *episcopus* when the Latins adopted it. They introduced it among the Saxons, with whom, by losing something both at the beginning and the end, it became *piscop*, or, as written in Anglo-Saxon characters, Biꝛceoþ. This is the modern *bishop*, in which it is probable that the change in the orthography (though small) is greater than in the enunciation. Other modern languages retain in like manner the Greek term slightly

modified according to the peculiar genius of each, as the Italian *vescovo;* Spanish, *obispo;* and French *évêque;* as well as the German, *bischof;* Dutch, *bisschop;* and Swedish, *biskop.*

The word *episcopus* literally signifies "an inspector or superintendent;" and the etymological sense expresses even now much of the actual sense of the word. The peculiar character of the bishop's office might be expressed in one word—superintendency. The bishop is the overseer, overlooker, superintendent in the Christian Church, and an exalted station is allotted to him, corresponding to the important duties which belong to his office. It was not, however, a term which was invented purposely to describe the new officer which Christianity introduced into the social system. The term existed before, both among the Greeks and Latins, to designate certain civil officers to whom belonged some species of superintendency. (See Harpocrat. or Suidas in voc. *ἐπίσκοπος.*) Cicero ('ad Att.' lib. vii. ep. 11) speaks of himself as appointed an *ἐπίσκοπος* in Campana.

It has long been a great question in the Christian Church what kind of superintendency it was that originally belonged to the bishop. This question, as to whether it was originally a superintendency of pastors or of people, may be briefly stated thus:—Those who maintain that it was a superintendency of pastors challenge for bishops that they are an order of ministers in the Christian Church distinct from the order of presbyters, and standing in the same high relation to them that the apostles did to the ordinary ministers in the church; that, in short, they are the successors and representatives of the apostles, and receive at their consecration certain spiritual graces by devolution and transmission from them, which belong not to the common presbyters. This is the view taken of the original institution and character of the bishop in the Roman Catholic Church, in the English Protestant Church, and we believe in all churches which are framed on an episcopal constitution. Episcopacy is thus regarded as of divine institution, inasmuch as it is the appointment of Jesus Christ and the apostles, acting in affairs of the Church under a divine direction. There are, on the other hand, many persons who contend that the superintendency of the bishop was originally in no respect different from the superintendency exercised by presbyters as pastors of particular churches. They maintain that, if the question is referred to scripture, we there find that bishop and presbyter are used indifferently to indicate the same persons or class of persons, and that there is no trace in the scripture of two distinct orders of pastors; and that if the reference is made to Christian antiquity, we find no trace of such a distinction till about 200 years after the time of the apostles. The account which they give of the rise of the distinction which afterwards existed between bishops and mere presbyters is briefly this:

When, in the ecclesiastical writers of the first three centuries, we read of the bishops, as of Antioch, Ephesus, Carthage, Rome, and the like, we are to understand the presbyters who were the pastors of the Christian churches in those cities. While the Christians were few in each city, one pastor would be sufficient to discharge every pastoral duty among them; but when the number increased, or when the pastor became enfeebled, assistance would be required by him, and thus other presbyters would be introduced into the city and church of the pastor, forming a kind of council around him. Again, to account for the origin of dioceses or rural districts which were under the superintendency of the pastors, it was argued that it was the cities which first received Christianity, and that the people in the country places remained for the most part heathens or pagans (so called from *pagus,* a country village) after the cities were Christianised; but that nevertheless efforts were constantly being made to introduce Christian truth into the villages around the chief cities; and that whenever favourable opportunities were presented, the chief pastor of the city encouraged the erection of a church, and appointed some presbyter either to reside constantly in or near to it, or to visit it when his services were required, though still residing in the city, and there assisting the chief pastor in his ministrations. The extent of country which thus formed a diocese of the chief pastor would depend, it is supposed, on the civil distributions of the period; that is, the dioceses of the bishops of Smyrna, or any other ancient city, would be the country of which the inhabitants were accustomed to look to the city for the administration of justice, or in general to regard it as the seat of that temporal authority to which they were immediately subject.

All this is represented as having gone on without any infringement on the rights of the chief pastor, of whom there was a regular series. Lists of them are preserved in many of the more ancient churches, ascending, on what may be regarded sufficient historical testimony, and with few breaks in the continuity, even into the second and first centuries. Bishops are however found in churches for which this high antiquity cannot be claimed. In these cases they are supposed to be either in countries which did not fully receive Christianity in the very earliest times, or that the bishops or chief pastors delegated a portion of that superior authority which they possessed over the other presbyters to the presbyter settled in one of the churches which was originally subordinate. This is supposed to have been the origin of the distinction among the chief pastors of bishops and archbishops, there being still a slight reservation of superintendency and authority in the original over the newly created chief pastors.

If this view of the origin of the episcopal character and office be correct, it will follow that originally there was no essential difference between the bishop and the presbyter, and also that the duties which belong to the pastor of a Christian congregation were performed by the bishop. But when the increase of the number of Christians rendered assistants necessary, and this became a permanent institution, then the chief pastor would divest himself of those simpler and easier duties, which occasioned nevertheless a great consumption of time, as a matter at once of choice and of necessity. Having to think and to consult for other congregations beside that which was peculiarly his own, and to attend generally to schemes for the protection or extension of Christianity, he would have little time remaining for catechising, preaching, baptising, or other ordinary duties; and especially when it was added that he had to attend councils, and even was called to assist and advise the temporal governors in the civil and ordinary affairs of state. When Christianity, instead of being persecuted, was countenanced and encouraged by the temporal authorities, it was soon perceived that the bishop would be a very important auxiliary to the temporal authorities; while in ages when few besides ecclesiastical persons had any share of learning, or what we call mental cultivation, it is manifest that the high offices of state, for the performance of the duties of which much discernment and much information were required, must necessarily be filled by ecclesiastics, who might be expected, as we know to have been the case, to unite spiritual preeminence with their high political offices. The Lord High Chancellor of England was always an ecclesiastic, and generally a bishop, to the time of Sir Thomas More, in the reign of Henry VIII.

The functions which belong to the bishop are in all countries nearly the same. We shall speak of them as they exist in the English Church. 1. Confirmation, when children on the threshold of maturity ratify or confirm the engagement entered into by their sponsors at baptism, which is done in the presence of a bishop, who may be understood in this ceremony to recognise or receive into the Christian Church the persons born within his diocese. 2. Ordination, or the appointment of persons deemed by him properly qualified, to the office of deacon in the church, and afterwards of presbyter or priest. 3. Consecration of presbyters when they are appointed to the office of bishop. 4. Dedication, or consecration of edifices erected for the performance of Christian services, or of ground set apart for religious purposes, as especially for the burial of the dead. 5. Institution or collation to vacant churches in his diocese. 6. Superintendence of the conduct of the several pastors in his diocese, in respect of morals, of residence, and of the frequency and proper performance of the public services of the church. And 7, Excommunication; and, in the case of ministers, deprivation and degradation.

These are the most material of the functions which have been retained by the Christian bishops, or, if we adopt the theory of apostolic succession, which have from the beginning been exercised by them. To these it remains to be added, that in England they are the medium of communication between the king and the people in respect of all affairs connected with religion; and that they are an important constituent part of that great council of the realm which is called parliament.

Whatever kind of moot, assembly, or council for the advice of the king there was in the earliest times of the English monarchy, the bishops were chief persons in it. The charters of the early Norman kings usually run in the form that they are granted by the assent and advice of the bishops as well as others; and when the ancient great council became moulded into the form of the modern parliament, the bishops were seated, as we now see them, in the Upper House. It is argued that they sit as barons [BARON], but the writ of summons runs to them as bishops of such a place, without any reference to the temporal baronies held by them. Down to the period of the Reformation they were far from being the only ecclesiastical persons who had seats among the hereditary nobility of the land, many abbots and priors having been summoned also, till the houses over which they presided were dissolved, and their office thus extinguished. Henry VIII. created at that time six new bishoprics, and gave the bishops placed in them seats in the same assembly. But before the nation had adjusted itself in its new position, there was a powerful party raised in the country, who maintained that a government of the church by bishops was not accordant to the primitive practice, and who sought to bring back the administration of ecclesiastical affairs to the state in which there was an equality among all ministers, and where the authority was vested in synods and assemblies. Churches upon this model had been formed at Geneva and in Scotland; and when this party became predominant in the parliament of 1642, a bill was passed for removing the bishops from their seats, to which the king gave a reluctant and forced assent. It was soon followed by an entire dissolution of the Episcopal Church. At the Restoration this Act was repealed, or declared invalid, and the English bishops have ever since had seats in the House of Lords, except that on the erection of Manchester into a see, it was enacted that the bishop last instituted shall not have a seat, and the bishop of Sodor and Man never had one. They form the Lords Spiritual, and constitute one of the three estates of the realm, the Lords Temporal and the Commons (the *tiers état*) being the other two. Out of this has arisen the question, now laid at rest, whether a bill has passed the House in a constitutional manner, if it has happened that no Lord Spiritual was present at any of its stages. When the House becomes a court for the trial of a peer

charged with a capital offence, the bishops withdraw, it being held unsuitable to the character of ministers of mercy and peace to intermeddle in affairs of blood.

For the execution of many of the duties belonging to their high function they have officers, as chancellors, judges, and officials, who hold courts in the bishop's name.

The election of bishops is supposed, by those who regard the order as not distinguished originally from the common presbyter, to have been in the people who constituted the Christian church in the city to which they were called; afterwards, when the number of Christians was greatly increased, and there were numerous assistant presbyters, in the presbyters and some of the laity conjointly. But after a time the presbyters only seem to have possessed the right, and the bishop was elected by them assembled in chapter. The nomination of such an important officer was, however, an object of great importance to the temporal sovereigns; and they so far interfered, that at length they virtually obtained the nomination. In England there is still the shadow of an election by the chapters in the cathedrals. When a bishop dies, the event is certified to the king by the chapter. The king writes to the chapter that they proceed to elect a successor. This letter is called the *congé d'élire*. The king, however, transmits to them at the same time the name of some person whom he expects them to elect. If within a short time they do not proceed to the election, the king may nominate by his own authority; if they elect any other than the person named in the king's writ, they incur the severe penalties of a præmunire, which includes forfeiture of goods, outlawry, and other evils. The bishop thus elected is confirmed in his new office under a royal commission, when he takes the oaths of allegiance, supremacy, canonical obedience, and against simony. He is next installed, and finally consecrated, which is performed by the archbishop or some other bishop named in a commission for the purpose, assisted by two other bishops. No person can be elected a bishop who is under thirty years of age.

The bishops in England have fixed salaries assigned to them, arising from their original endowments; but in some cases the estates are left in the hands of the bishops, who pay over the surplus, if any, to commissioners who have the management of others, paying the salary to the bishop. Their churches, which are called *cathedrals*, (from *cathedra*, a seat of dignity,) are noble and splendid edifices, the unimpeachable witnesses remaining among us of the wealth, the splendour, and the architectural skill of the ecclesiastics in England in the middle ages. The cathedral of the Bishop of London is the only modern edifice.

For other information on this subject, see ARCHBISHOP and ARCHDEACON.

Bishops in partibus.—This is an elliptical phrase, and is to be supplied with the word *Infidelium*. These are bishops who have no actual see, but who are consecrated as if they had, under the fiction that they are bishops in succession to those who were the actual bishops in cities where Christianity is extinct. Syria, Asia Minor, Greece, and the northern coast of Africa, present many of these extinct sees, some of them the most ancient and most interesting in the history of Christianity. When a Christian missionary is to be sent forth in the character of a bishop into a country imperfectly Christianised, and where the converts are not brought into any regular church order, the Pope does not consecrate the missionary as the bishop of that country in which his services are required, but as the bishop of one of the extinct sees, who is supposed to have left his diocese and to be travelling in those parts.

Suffragan Bishops.—In England, every bishop is, in certain views of his character and position, regarded as a suffragan of the archbishop in whose province he is. But the suffragan bishop is rather to be understood as a bishop *in partibus*, who was admitted by the English bishops before the Reformation to assist them in the performance of the duties of their office. When a bishop filled some high office of state, the assistance of a suffragan was almost essential, and was probably usually conceded by the Pope, to whom such matters belonged, when asked for. A catalogue of persons who have been suffragan bishops in England was made by Wharton, a great ecclesiastical antiquary, and is printed in an appendix to a Dissertation on bishops *in partibus*, published in 1784 by another distinguished church-antiquary, Dr. Samuel Pegge.

At the Reformation, provision was made for a body of suffragans. The Act 26 Henry VIII. c. 14, is expressly on this subject. It authorises each archbishop and bishop to name a suffragan, which is to be done in this manner: he is to present the names of two clerks to the king, one of whom the king is to select. He was no longer to be named from some extinct see, but from some town within the realm. Six-and-twenty places are named as the seats (nominally) of the suffragan bishops. They were these which follow:

Thetford,	Shaftesbury,	Bristol,	Cambridge,
Ipswich,	Molton,	Penrith,	Pereth,
Colchester,	Marlborough,	Bridgewater,	Berwick,
Dover,	Bedford,	Nottingham,	St. Germains,
Guildford,	Leicester,	Grantham,	and the
Southampton,	Gloucester,	Hull,	Isle of Wight.
Taunton,	Shrewsbury,	Huntingdon,	

This was before the establishment of the six new bishoprics.

Very few persons were nominated suffragan bishops under this Act. One, whose name was Robert Pursglove, who had been an abbot, and who was a friend to education, was suffragan bishop of Hull. He died in 1579, and lies interred in the church of Tideswell in Derbyshire, under a sumptuous tomb, on which is his effigy in the episcopal costume with a long rhyming inscription presenting an account, curious as being contemporary, of the places at which he received his education, and the ecclesiastical offices which in succession he filled.

Boy-bishop.—In the cathedral and other greater churches, it was usual on St. Nicholas-day to elect a child, usually one of the children of the choir, bishop, and to invest him with the robes and other insignia of the episcopal office; and he continued from that day (Dec. 6), to the feast of the Holy Innocents (Dec. 28), to practise a kind of mimicry of the ceremonies in which the bishop usually officiated, more for the amusement than to the edification of the people. The custom, strange as it was, existed in the churches on the continent as well as in England. It may be traced to a remote period. It was countenanced by the great ecclesiastics themselves, and in their foundation they sometimes even made provision for these ceremonies. This was the case with the archbishop of York in the reign of Henry VII., when he founded his college at Rotherham. Little can be said in favour of such exhibitions, but that they served to abate the dreariness of mid-winter. Much may be found collected on this subject in Ellis's edition of Brand's 'Popular Antiquities,' vol. i. The custom was finally suppressed by a proclamation of Henry VIII., in 1542.

BISHOPRIC is a term equivalent to diocese or see, denoting the whole district through which the bishop's superintendency extends. The final syllable is the Anglo-Saxon ꝛice, *region*, which entered in like manner into the composition of one or two other words.

In England there are two archbishoprics and twenty-one bishoprics; in Wales four bishoprics; the Isle of Man forms also a bishopric, but the bishop has no seat in the English Parliament.

The basis of the present diocesan distribution of England was laid in the times of the Saxon Heptarchy. At the Conquest there were two archbishoprics and thirteen bishoprics, namely,

Canterbury,	Rochester,	Hereford,
York,	Salisbury,	Coventry and Lichfield,
London,	Bath and Wells,	Lincoln,
Winchester,	Exeter,	Norwich,
Chichester,	Worcester,	Durham.

The first innovation on this arrangement was made by King Henry I., who, to gratify the abbot of the ancient Saxon foundation at Ely, and to free him from the superintendence of the Bishop of Lincoln, in whose diocese he was, erected Ely into a bishopric, the church of the monastery being made the cathedral. He assigned to it as its diocese the county of Cambridge and some portion of Norfolk, perhaps as much as had formerly been comprehended within Mercia; for we have no better guide to the exact limits of the ancient Saxon kingdoms than the limitations of the ancient dioceses. This was effected in 1109.

The second was in 1133, near the end of the reign of Henry I., when the see of Carlisle was founded. The diocese consists of portions of the counties of Cumberland and Westmoreland, perhaps not before comprehended within any English diocese.

No other change took place till 1541, when King Henry VIII. erected six new bishoprics, facilities for doing so being afforded by the dissolution of the monastic establishments, which placed at the king's disposal large and splendid churches, and great estates, out of which to make a provision for the support of the bishops. These were: 1. Oxford, having for its diocese the county of Oxford, which had previously been included within the diocese of Lincoln. 2. Peterborough: this diocese was also taken out of that of Lincoln, and comprises the county of Northampton and the greater portion of Rutland. 3. Gloucester, having for its diocese the county of Gloucester, which had been previously in the diocese of Worcester. 4. Bristol, to which the city of Bristol, and the whole county of Dorset heretofore belonging to the diocese of Salisbury, were assigned. 5. Chester: to this a very large tract was assigned, namely, the county of Chester, heretofore part of the diocese of Lichfield and Coventry, and the whole county of Lancaster, part of Cumberland, and the archdeaconry of Richmond, all of which were before in the diocese of York. 6. Westminster, the county of Middlesex, which before had belonged to the diocese of London, being assigned to it as its diocese. This last bishopric however soon fell. In about nine years, Thirlby, the first and only bishop, was translated to the see of Norwich, and the county of Middlesex was restored to the diocese of London.

Since the year 1541 no change took place in the diocesal distribution of England until 1836, when, in order to lessen the great disproportion of the sees, the bishopric of Ripon was formed under the 6 & 7 Wm. IV. c. 77, consisting of detached parts of the dioceses of York and Chester, and the bishoprics of Gloucester and Bristol were united. Provision was also made for the creation of a bishopric of Manchester, for which room was to be made by uniting the sees of Bangor and St. Asaph. This part of the plan was subsequently abandoned, and in 1847 Manchester was erected into a bishopric, with a provision that no greater number of bishops should have a seat in the House of Lords, and, therefore, that the junior bishop (except of the bishoprics of London, Winchester or Durham) should be the one without a seat. The

diocese of Manchester consists of the whole county of Lancaster, except the deanery of Furnes and Cartmel. The Act 6 & 7 Wm. IV. made provision for uniting the see of Sodor and Man to that of Carlisle; but by 1 Vict. c. 30, its existence as a separate bishopric was preserved. The Act 6 & 7 Wm. IV. c. 77, not only remodelled dioceses, but provided for a more equal distribution of episcopal revenues, according to the following scale :—

ARCHBISHOPS.

Canterbury	£15,000
York	10,000

BISHOPS.

London	10,000
Durham	8,000
Winchester	7,000
Ely	5,500
St. Asaph and Bangor	5,200
Worcester	5,000
Bath and Wells	5,000

The other bishoprics are augmented by fixed contributions out of the revenues of the richer sees, so as to increase their average annual incomes to not less than 4000*l.* nor more than 5000*l.* The surplus revenues from the richer sees are paid into the hands of the Ecclesiastical Commissioners, and constitute what is called the Episcopal Fund; and every seven years, from Jan. 1, 1837, a new return is to be made by them of the revenues of all the bishoprics, and thereupon the scale of episcopal payments is to be revised, so as to preserve the scale fixed upon by the Act. Provision was also made in this Act for a more equal distribution of patronage among the several bishops, proportioned to the relative magnitude and importance of their respective dioceses.

The bishops of London, Durham, and Winchester rank next to the archbishops; the others rank according to priority of consecration.

While the Church of Scotland was episcopal in its constitution it had two archbishoprics, St. Andrew's and Glasgow, and eleven bishoprics, to which, as late as 1633, a twelfth was added, the bishopric of Edinburgh. In the other thirteen sees there is a long and pretty complete catalogue of bishops, running up to the 9th, 10th, 11th, or 12th centuries. The eleven ancient bishoprics were those of Aberdeen, Argyle, Brechin, Caithness, Dumblane, Dunkeld, Galloway, Moray, Orkney, Ross, and the Isles, or Sodor, a see which was formerly within the superintendency of the bishop of Man.

At the Revolution, the Presbyterian Church of Scotland was acknowledged as the national church; but there is still an episcopal church in Scotland, the members of which are there in the character of dissenters. The sees are Edinburgh, which is the seat of the primacy, Glasgow, Aberdeen, St. Andrew's, Brechin, Argyll, and Moray and Ross.

Before the changes in the Irish establishment, effected in 1833 by the 3 & 4 Wm. IV. c. 37, and the 4 & 5 Wm. IV. c. 90, there were four archbishoprics and eighteen bishoprics. Many of the latter had been formed by the union of sees, which had been effected at different epochs. At the time of the passing of the Act there were in the province of

Armagh.—Meath and Clonmacnoise, Clogher, Down and Connor, Kilmore, Dromore, Raphoe, and Derry.

Dublin.—Kildare, Ossory, and Ferns and Leighlin.

Cashel.—Limerick, Cork and Ross, Waterford and Lismore, Cloyne, and Killaloe and Kilfenora.

Tuam.—Elphin, Clonfert and Kilmacduagh, and Killala and Achonry.

By the Act mentioned, the archiepiscopal diocese of Tuam was united to that of Armagh, and that of Cashel to Dublin; but the two suppressed archbishoprics are now bishoprics. The diocese of Dromore is united to that of Down and Connor; that of Raphoe to Derry; Clogher to Armagh; Elphin to Kilmore; Killala and Achonry to Tuam and Ardagh; Clonfert and Kilmacduagh to Killaloe and Kilfenora; Kildare to Dublin and Glandelagh; Leighlin and Ferns to Ossory; Waterford and Lismore to Cashel and Emly; Cork and Ross to Cloyne. The diocese of Meath and Clanmacnoise, and that of Limerick, remained unaltered. The archbishoprics are reduced to two, and the bishoprics to ten. A large saving was effected by the amalgamation, and the surplus revenue arising from the suppressed sees is under the management of the Ecclesiastical Commissioners of Ireland, to be dispensed for ecclesiastical and educational purposes.

One archbishop and three bishops represent the Irish Church in the House of Lords. They are changed every session, according to a system of rotation by which all sit in turn.

The bishropric of Man is traced to Germanne, one of the companions of St. Patrick, in the 5th century; but there are many breaches in the series of bishops from that time to the present. Sodor, which is supposed to be a Danish term for the western Isles of Scotland, was under the same bishop till the reign of Richard II., when the Isle of Man having fallen under the English sovereignty, the Islands withdrew themselves, and had a bishop of their own. The nomination of the bishop was in the house of Stanley, earl of Derby, from whom it passed by an heiress to the Murrays, dukes of Athol, and has come by purchase to the crown. This bishopric was declared by an Act of 33 Henry VIII. to be in the province of York.

The Isle of Wight is part of the diocese of Winchester; and the isles of Jersey and Guernsey, with the small islands adjacent, are in the diocese of London.

The bishoprics in the British colonies have become numerous by the creation of new sees. The oldest colonial bishopric was that of Nova Scotia, created in 1787. In 1841 a meeting was held of the archbishops and bishops of England and Ireland at Lambeth Palace, when it was agreed to undertake the charge of funds then raising for the endowment of bishoprics in the colonies, and to become responsible for their application. In no case do they proceed without the concurrence of the government. They now consist of,—in North America, Nova Scotia, Quebec, Montreal, Toronto, Fredericton, Huron, Prince Rupert's Land, British Columbia, and Newfoundland; in Australasia, Sydney, Tasmania, Adelaide, Melbourne, Newcastle, Perth, Brisbane, New Zealand, Christchurch, Wellington, and Waiapu; in the West Indies, Jamaica, Barbadoes, Antigua, and Guiana in South America; in the East Indies, Calcutta, Bombay, Madras, Ceylon, and the islands of Mauritius and Labuan, and also Victoria (Hong Kong); in Africa, Cape Town, Natal, Graham's Town, and Sierra Leone; and in Europe, Gibraltar. British colonies or dependencies which are not within any diocese are considered to be under the pastoral care of the Bishop of London.

There are thirty-three Roman Catholic archbishops, bishops, coadjutor bishops, and vicars-apostolic in the British colonies. At Sydney, Quebec, and in Bengal, the Roman Catholic prelates are of the rank of archbishops.

In 1840, a very important Act (3 & 4 Vict. c. 86) was passed "for better enforcing Church Discipline," which repealed the old statute (1 Hen. VII. c. 4), under which bishops were enabled to proceed against their clergy, and sentence them to imprisonment. The new Act provides "that in every case of any clerk in holy orders of the United Church of England and Ireland who may be charged with any offence against the laws ecclesiastical, or concerning whom there may exist scandal or evil report as having offended against the said laws, it shall be lawful for the bishop of the diocese within which the offence is alleged or reported to have been committed, on the application of any party complaining thereof, or if he shall think fit, of his mere motion, to issue a commission under his hand or seal to five persons, of whom one shall be his vicar-general, or an archdeacon or rural dean within the diocese, for the purpose of making inquiry as to the grounds of such charge or report; provided always that notice of the intention to issue such commission under the hand of the bishop, containing an intimation of the nature of the offence, together with the names, addition, and residence of the party on whose application or motion such commission shall be about to issue, shall be sent by the bishop to the party accused fourteen days at least before such commission shall issue." The bishop may at once pronounce sentence, by consent of the clerk; and such sentence is good and effectual in law. If he refuse or neglect to appear and make answer to the articles alleged against him, other than an unqualified admission of the truth thereof, "the bishop shall proceed to hear the cause, with the assistance of three assessors, to be nominated by the bishop, one of whom shall be an advocate who shall have practised not less than five years in the court of the archbishop of the province, or a sergeant-at-law, or a barrister of not less than seven years' standing, and another shall be the dean of his cathedral church, or of one of his cathedral churches, or one of his archdeacons, or his chancellor; and upon the hearing of such cause the bishop shall determine the same, and pronounce sentence thereupon according to the ecclesiastical law." While the charge is under investigation, the bishop may inhibit the party accused from performing any services of the church within his diocese until sentence has been passed; but if the person accused be the incumbent of a benefice, he may nominate any person or persons to perform such services during his inhibition, and such persons are to be licensed by the bishop if they are approved of by him. Appeals under the Act are to the archbishop, and they are to be heard before the judge of the court of appeal in his province; but if the cause has been heard and determined in the first instance in the court of the archbishop, the appeal is then to the Queen in Council, and is to be heard before the Judicial Committee of Privy Council, and at least one archbishop or bishop must be present.

In matters of dispute between a diocesan and his clergy, an appeal lies to the archbishop of the province in all cases excepting curates' stipends (1 & 2 Vict. c. 106).

Rolle, an old authority, contended that the archbishop might appoint a coadjutor to one of his suffragans who is infirm or incapable. This power is now established by 6 & 7 Vict. c. 62, entitled "An Act to provide for the performance of the episcopal functions in case of the incapacity of any bishop or archbishop."

In 1841 a bishop of the United Church of England and Ireland was appointed for Jerusalem. The King of Prussia first suggested the appointment to Queen Victoria, and the right of appointing the bishop is enjoyed alternately by the crowns of Prussia and England; but the Archbishop of Canterbury has a veto on the selection by Prussia. The Bishop of Jerusalem is a suffragan of the Archbishop of Canterbury; but he cannot exercise episcopal functions in the dominions of Great Britain, nor can the persons ordained by him. The Protestant Church of Jerusalem comprehends persons using different liturgies and subscribing different articles of faith, who will be on terms of equality as

members. The bishop may ordain Prussian clergymen, on their signing the Augsburg Confession, and adopting the Prussian liturgy; and Englishmen, on their subscribing to our articles and liturgy. He is the legal protector of all Protestants of every denomination against the Turkish government. The Act 5 Vict. c. 6, was passed to enable the archbishops of Canterbury and York, and such bishops as they might select, to consecrate a foreign bishop.

At the present time there are twenty-four bishops of the Protestant Episcopal Church of the United States of America. In this Church the superior powers of church government are vested in a General or National Convention, which meets triennially. The Convention consists of two houses. The bishops sit as a body in their own right, and form a separate House. The lower House is composed of lay and clerical delegates. Each diocese is represented by four laymen and four of the clergy, who are elected by local Diocesan Conventions. The lay members of the Diocesan Conventions are elected by their respective congregations or vestries. The general Convention, amongst other things, has the power of revising old, or making new canons. It hears and determines charges against bishops; receives and examines testimonials from Diocesan Conventions recommending new bishops, and decides upon their appointment; without the certificate of the General Convention, a bishop cannot be consecrated. The title assumed by a bishop in the United States is "Right Reverend."

The bishops of the Methodist Episcopal Church of the United States have no particular province or district. Their time is chiefly spent in attending the different annual conferences of the Church.

The Roman Catholic hierarchy in the United States is composed of one archbishop, fifteen bishops, and five coadjutors. The first Roman Catholic bishop in the United States was consecrated in 1790.

The Pope is the bishop of the Christian Church of Rome, and claims to be the successor of St. Peter, of whom it is alleged that he was the first bishop of that Church, and that to him there was a peculiar authority assigned, not only over all the inferior pastors or ministers of the Church, but over the rest of the apostles, indicated to him by the delivery of the keys. The whole of this, the foundation of that superiority which the bishop of Rome has claimed over all other bishops, has furnished matter of endless controversy; and it does not appear that there is any sufficient historical authority for the allegation that St. Peter did act for any permanency as the bishop of that Church, or for the six or seven persons named as successively bishops of that Church after him. It seems more probable that the superiority enjoyed by the bishop of Rome at a very early period over other bishops (which was not universally acknowledged, and was strenuously opposed by our own Welsh bishops), resulted from his position in the chief city of the world, and the opportunities which he enjoyed of constant access to those in whom the chief temporal authority was vested.

England and Wales was, soon after the Reformation, divided by the Roman Catholic Church into "Districts," over each of which a bishop was placed, who was a bishop *in partibus*. [BISHOP.] But in 1850, in consequence of a rescript issued by the Pope, a complete hierarchy was directed to be formed in Great Britain. England has, therefore, been divided into the archbishopric of Westminster, and the bishoprics of Southwark, Hexham, Beverley, Liverpool, Salford, Shrewsbury, Newport and Menevia, Clifton, Plymouth, Nottingham, Birmingham, and Northampton. This assumption created considerable agitation; and in August, 1851, the Ecclesiastical Titles Assumption Bill (14 & 15 Vict. c. 60) was passed, by which all briefs or rescripts of the pope conferring any such jurisdiction or title was declared void; any person publishing such bull or rescript, or acting on it, or assuming the title of archbishop or bishop of any city or place within the United Kingdom, was rendered liable to a penalty of 100*l.*, to be recovered in a court of law, but only with the consent of, or by, the Attorney-General in England or Ireland, and the Lord Advocate in Scotland. There has been no conviction under this Act.

In Scotland there are three Roman Catholic bishops, but there they continued to be bishops *in partibus;* they are the Bishop of Limyra for the Eastern district, the Bishop of Castabala for the Western district, and the Bishop of Germanicia for the Northern district.

The Roman Catholic hierarchy in Ireland consists of four archbishops and twenty-four bishops. In the Charitable Donations (Ireland) Act (7 & 8 Vict. c. 97) the Roman Catholic prelates were designated for the first time since the Reformation by their episcopal titles, which are taken from the same sees as those of the English Church, except Galway, which is not included among the English sees. They had been referred to in the bill, when first brought in, as "any person in the said Church [of Rome] of any higher rank or order," &c.; and, on the proposition of the government, this was altered to "any archbishop or bishop, or other person in holy orders, of the Church of Rome." In December, 1844, a royal commission was issued constituting the Board of Charitable Bequests in Ireland, and the two Roman Catholic archbishops and bishop who were appointed members of the Board were styled "Most Reverend" and "Right Reverend," and had precedency according to their episcopal rank; but they were only styled archbishop or bishop with their proper names, not with the addition of any see.

It is stated in a recent authority that the number of Roman Catholic archbishops in Europe is 108, and of bishops 469; and that there are 154 bishops in other parts of the world; making a total of 731 bishops. In France there are 14 archbishops, and 66 bishops.

The Eastern or Greek Church is also framed in an episcopal form and order, and the sees are very numerous.

BISMETHYL, *Bismuthethyl.* [ORGANOMETALLIC BODIES.]

BISMUTH (Bi). This metal occurs in nature either in the free state, as native bismuth, or as oxide, carbonate, sulphide, or telluride. Native bismuth, which furnishes almost all the metal employed in the arts, is found in the clay-slate and gneiss formations, generally associated with silver, lead, zinc, cobalt, or nickel, and containing variable quantities of arsenic and iron. It crystallises in cubes and octohedra, and in arborescent forms derived from these, its colour being a very light grey inclining to red. Native bismuth is found in Cumberland and Cornwall, but its principal source is Schneeberg, in Saxony, where it accompanies the silver and cobalt ore. The extraction of native bismuth from the matrix is conducted at Schneeberg as follows: The fragments of rock richest in the metal are reduced to pieces about the size of a hazel nut. It is then introduced into a series of cast-iron tubes, arranged parallel to one another in an inclined position. Each end of every tube is closed by a plate of clay, a hole being left at the bottom of the lower clay-plate of every tube for the egress of the melted metal. On bringing the tubes to a white heat, the metal flows out and falls into cast-iron cups, which are kept sufficiently hot to retain the bismuth in a state of fusion. From these cups the bismuth is ladled into ingot moulds. In order to free the metal from arsenic and iron, with which it is contaminated, it is submitted to a fresh fusion with nitrate of potash; the foreign metals are thereby oxidised, and dissolve in the slag. If a crucible full of fused bismuth be allowed to cool slowly, the solid crust which forms on its surface be broken through, and the still fluid portion be poured out, the inner surface of the solidified portion is found covered with crystals of bismuth, of the cubic and derived forms, of great regularity. The iridescence which such bismuth shows, is owing to the edges of the successively-formed layers of metal not being in one plane. On solidifying from a state of fusion, bismuth undergoes an expansion of about $\frac{1}{32}$ of its volume; this property renders the alloys of bismuth (to which it imparts the same peculiarity) of great value for taking sharp castings, as in the manufacture of type; for such an alloy, at the moment of solidification, is forced into the minutest crevices of the mould. Cast bismuth has the specific gravity 9·86; but after being submitted to enormous pressure, its density is diminished to 9·65. Bismuth is so brittle as scarcely to admit of extension under the hammer. It melts at 497° F., when heated alone; but it depresses the melting point of many metals with which it is alloyed. The solder used for pewter consists of 1 part of bismuth, 5 of lead, and 1 of tin. Fusible metal, which melts at 199° F., contains 5 parts of bismuth, 3 of lead, and 2 of tin. A similar alloy, of higher melting point, is sometimes employed to form safety-plugs for boilers.

There is some uncertainty respecting the atomic weight of bismuth, and consequently as to the composition of its oxides, &c. The analogy between bismuth and antimony makes it probable that these two metals combine with oxygen in the same proportion. According to this, the protoxide of bismuth is BiO_3, and the equivalent of the metal between 213 and 210.

There is probably no lower *oxide of bismuth* than the teroxide. When the metal oxidises in moist air, or when it is made to form the positive pole of a battery in a solution of a fixed alkali, it becomes covered with coatings of oxide of various colours. On treating the film so formed with hydrochloric acid, it is converted into metallic bismuth and teroxide.

Teroxide of bismuth (BiO_3) is produced when air has access to melted bismuth. Most salts of the teroxide, as the nitrate and carbonate, when heated, give off their acids, and leave the teroxide in the form of a dark orange-yellow powder, which becomes nearly white on cooling. The hydrated teroxide is precipitated as a white powder by decomposing a soluble salt of bismuth by a fixed alkali or by ammonia. If, however, the chloride be employed, the precipitated bismuth contains chlorine, probably in the form of oxychloride.

The teroxide of bismuth combines with various proportions of acids; of the salts resulting from such combination, those which contain most acid are more soluble than those which contain an excess of base. Most of the solutions of the acid bismuth salts are decomposed by water, less soluble basic salts being formed, and in most cases precipitated, owing to their inferior solubility. This property is of much value as a test for bismuth. Teroxide of bismuth combines with sulphuric acid in four proportions. The *tersulphate* ($BiO_3 3SO_3$) is formed when metallic bismuth is heated with oil of vitriol, sulphurous acid and sulphur being at the same time liberated; the tersulphate of bismuth so formed is a white mass which is decomposed by water into a salt which dissolves, and which contains more acid than the tersulphate, but whose composition is undetermined, though it may be obtained as acicular crystals by evaporation; and the *monosulphate* (BiO_3SO_3), an insoluble white powder, which becomes yellow on heating. The same monosulphate may also be formed by dissolving the teroxide in sulphuric acid, and evaporating and gently igniting the solution. The *bisulphate* ($BiO,2SO_3 + 3HO$) separates out in the crystalline form on decomposing the acid nitrate of bismuth with sulphuric acid; it is decomposed by water. Hydrated teroxide of bismuth combines with sulphurous acid, and gives rise to a white nsoluble sulphite, which gives up its acid on ignition.

Nitric acid combines with teroxide of bismuth in three proportions. If metallic bismuth, or the teroxide, be treated with nitric acid in excess, a soluble ternitrate of bismuth is formed (in the former case with evolution of nitrogen oxides), if the acid be not too dilute. On evaporating such a solution of ternitrate in nitric acid at a gentle heat, colourless transparent prismatic crystals are formed, containing nine or ten equivalents of water. Both the crystallised ternitrate and its solution in nitric acid may be dissolved in nitric acid without decomposition. Water decomposes the salt in both conditions; the amount of decomposition effected in the latter case depending upon the quantity of free nitric acid present. The white powder thrown down by water from a solution of the ternitrate is the *mononitrate* $BiO_3NO_5 + HO$, which is the Bismuth-white or Pearl-white of the arts, also called the Magistery of Bismuth, and used as a cosmetic. It is prepared commercially by boiling dilute nitric acid with bismuth until no more is taken up, adding water until a precipitate begins to form, filtering, and adding from 30 to 100 times as much water by weight as there is metallic bismuth in solution. The precipitated mononitrate is collected on a filter, washed with cold water, and dried between blotting-paper. It is a white powder, of pearly lustre, and crystalline constituence. According to Becker ('Ann. Pharm.' 68, 282), nitric acid combines with bismuth in three other proportions, namely, $5\,BiO_3 4NO_5 + 9HO$ (and $5\,BiO_3 4\,NO_5 + 12\,HO$), $6\,BiO_3 5\,NO_5 + 9\,HO$, and $4\,BiO_3 3\,NO_5 + 9\,HO$.

The teroxide of bismuth forms salts with ordinary bibasic and monobasic *phosphoric acids;* these bodies, however, have been but little examined. The same may be said of the bromate and iodate; the former, obtained by treating hydrated teroxide with bromic acid, has the composition $3\,BiO_3\,2\,BrO_5 + 6\,HO$, and is insoluble (there is also a more acid bromate); the latter, formed by double decomposition, is a white powder, insoluble in water.

Carbonate of bismuth occurs in nature. The composition of the native carbonate is doubtful. A monobasic carbonate is precipitated as a white insoluble powder, on mixing a solution of the nitrate with one of an alkaline carbonate; its composition is $BiO_3CO_2 + HO$.

Boracic and *Silicic* acids combine with the teroxide of bismuth, both are insoluble in water; the former is obtained by double decomposition, the latter occurs in nature as bismuth-blende ($BiO_3 2\,SiO_3$), in minute dodecahedral crystals of dark yellow colour, contaminated with arsenic, cobalt, copper, iron, and manganese.

Quadroxide of Bismuth (BiO_4) is a brown powder, formed by boiling the hydrated teroxide with the chlorite of an alkali containing an excess of alkali. If teroxide of bismuth be thrown upon fused caustic potash it dissolves, and undergoes further oxidation by the oxygen which the potash acquires from the air. After cooling, the mass is exhausted with water, which removes the excess of potash, and leaves a yellow insoluble body of the composition $KO_6BiO_3, 2BiO_5$, being the *bismuthate of bismuth and potash*. Brown and purple compounds of potash with the ter- and pent-oxides of bismuth have been also formed.

Pentoxide of Bismuth, or *bismuthic acid* (BiO_5), is formed by fusing hydrate of soda with teroxide of bismuth; boiling the product with caustic soda, and washing the brown powder so formed, which is probably a bismuthate of bismuth and soda, with nitric acid, which removes the teroxide and soda, and finally with water. Bismuthic acid is a brown powder, which gives off oxygen when heated alone, or when treated with sulphuric or phosphoric acids. It evolves chlorine from hydrochloric acid; in all cases being reduced to the teroxide.

It is doubtful whether bismuth combines with *hydrogen* alone. If bismuth form the negative pole of a battery in a decomposition cell containing water, a black arborescent crust is obtained.

The most important *haloid* compounds of bismuth are the chloride, bromide, iodide, and sulphide.

Chloride of Bismuth ($BiCl_3$). Powdered bismuth, when thrown into dry chlorine gas, takes fire, burning with a blue flame, and forming a gray-white, granular, easily fusible mass, which may be volatilised without decomposition in an atmosphere of carbonic acid. The same substance is formed by dissolving the teroxide in hydrochloric acid, evaporating, and distilling. The vapour density of terchloride of bismuth is 11·35. By gently evaporating a solution in hydrochloric acid, a crystalline terhydrate of the terchloride is formed. Both the anhydrous and hydrated chlorides are decomposed by water, a portion of the bismuth being precipitated as *Oxychloride of bismuth* ($Bi_3Cl_3O_6$), a white crystalline powder, fusible at a red heat. The same oxychloride may be formed by precipitating ternitrate of bismuth with hydrochloric acid, or an alkaline chloride.

Bromine does not act so energetically as chlorine upon bismuth. To effect the union of the two, powdered bismuth is heated in a tube with an excess of bromine. The *terbromide of bismuth* ($BiBr_3$) so formed is freed from excess of bromine by a gentle heat. On cooling, the pure terbromide solidifies to a grey mass of submetallic lustre. It fuses at 392° Fahr., and volatilises at a red heat. It abstracts the water from moist air, and is converted into a hydrate. Like the chloride, it is decomposed by a larger quantity of water, oxybromide of bismuth being in this case formed.

Teriodide of bismuth (BiI_3). If a solution of iodide of potassium be added to a soluble salt of the teroxide of bismuth, and the formation of basic salts hindered by the addition of acetic acid, a brown crystalline body separates out; this is the teriodide of bismuth. The teriodide is slowly decomposed by cold water; boiling water decomposes it quickly, a red insoluble *oxyiodide* ($Bi_3I_3O_6$) being formed. Teriodide of bismuth dissolves in aqueous hydriodic acids; evaporation of such a solution yields the *hydrated hydriodate of the teriodide* ($BiI_3,HI, + 8HO$).

Lower iodides of bismuth, containing less iodine than the teriodide, are formed by heating iodine with powdered bismuth; their composition is doubtful.

Sulphur combines in two proportions with bismuth. The *bisulphide of bismuth* (BiS_2) is obtained in the form of quadratic prisms, of grey metallic lustre and of specific gravity 7·29, by fusing 10 parts of powdered bismuth with 3 parts of sulphur, and again fusing the mass so obtained two or three times with fresh portions of sulphur. On quickly cooling from the last fusion, a nest of crystals of the bisulphide are found in the interior of the mass.

The *tersulphide of bismuth*, BiS_3, occurs in nature as bismuth glance. It is formed artificially by precipitating bismuth from solutions of its tersalts with sulphuretted hydrogen. If sulphur and bismuth be fused together this compound is also formed; but all these varieties of the tersulphide lose sulphur when heated, being reduced to the bisulphide. Bismuth glance is of a lead grey colour, of specific gravity 6·5; it belongs to the right prismatic system.

Selenium, phosphorus, antimony, arsenic, and tellurium, combine directly with bismuth in indefinite proportions, as also do the metals potassium and sodium.

If the point of contact of two bars, one of bismuth and the other of antimony, be heated, and the other extremities metallically connected, an electric current circulates through the system. A series of such pairs constitutes the thermomultiplier.

For the organic compounds of bismuth, see ORGANO-METALLIC BODIES.

Bismuth in solution may be distinguished from all other metals by the conjunction of the following reactions:—1. It is precipitated from acid solutions by sulphuretted hydrogen. 2. The sulphide is insoluble in alkalies and their sulphides. 3. The sulphide is soluble in nitric acid. 4. The chloride is soluble in dilute hydrochloric acid. 5. The oxide is precipitated by ammonia from the ternitrate, terchloride, or tersulphate, and is insoluble in excess of that reagent. 6. All soluble salts are decomposed on being dropped into a large quantity of water, insoluble basic salts being formed.

BISMUTH, MEDICAL USES OF. Bismuth taken into the stomach in the state of a metal produces no effect upon the human system. It is therefore in the form of one of its preparations that it is employed as a medicinal agent; and for this purpose the sub-nitrate, called also the *magistery* of bismuth, and also, incorrectly, the white oxide of bismuth, is generally preferred. This is a white powder, sometimes in lumps resembling chalk, inodorous and tasteless. It is insoluble in water, and but slightly if at all soluble in the juices of the stomach, a circumstance which accounts for its limited sphere of action; hence its employment is almost entirely confined to affections of the stomach itself. In large doses, however, it is undoubtedly poisonous, and produces vomiting, with small pulse, faintings, and even death, the stomach exhibiting erosions and signs of inflammation. Even its external application is not free from danger, for the cosmetic termed *pearl white*, or *Spanish white*, which is subnitrate of bismuth, when applied for a length of time to the face, causes nervous twitchings, and finally paralysis. Subnitrate of bismuth is considered a tonic, and in nervous pains and cramps of the stomach it is decidedly antispasmodic. In what is termed *gastrodynia*, either given alone, or with one grain of opium, it is in general more efficacious than any other means in speedily removing the pain. It is also sometimes useful in *pyrosis*, especially if complicated with affections of the pancreas. In this case it is advantageously combined with rhubarb. Extract of hops is also an appropriate vehicle for it. In combination with magnesia it is stated by Dr. Theophilus Thompson to be useful in the diarrhœa of phthisis pulmonalis. Being insoluble in water it can never be administered in that vehicle.

Its employment has been proposed in hysteria, tetanus, and intermittent fever, but its utility is very slight when the cause of these diseases is remote from the stomach. In case of an overdose, tea, white of egg, or milk, are the best antidotes. As *pearl white* is blackened by sulphuretted hydrogen, the face of those who employ this cosmetic is blackened by the use of the Harrowgate or other sulphureous waters.

BISMUTHIC ACID. [BISMUTH.]

BISSEXTILE, or BISSEXTUS DIES, the name given in the Roman calendar, after its reformation by J. Cæsar, to the intercalary day which was inserted every fourth year between the 24th and 25th of February. The 24th of February was expressed according to the Roman reckoning, "sexto Calendas Martii,"—that is, the sixth day before the Calends, or first of March. When the intercalary day was inserted it was also called "sexto Calendas Martii;" and as the name was thus repeated, this day was called the *bissextus dies*, or the sixth day twice over. In legal reckoning, as to the birth of a child, the 24th and following day in the bissextile year were considered in the Roman law as one day. (See 'Dig.,' 4, tit. 4. 3.) In Greek, this day was called *ἐμβόλιμος ἡμέρα*, which signifies the same as intercalated day.

By the statute 21 Hen. III., the bissextile day and the day immediately preceding were to be considered legally as one day (computetur dies ille et dies proxime precedens pro uno die). In the English calendar the intercalated day in each leap year is placed at the end of February, which has twenty-nine days. [YEAR.]

BISTORT [POLYGONUM BISTORTA, or SNAKEWEED; NAT. HIST. DIV.] is an indigenous perennial plant, growing in woods and meadows. The root, which is the officinal part, is about the thickness of a finger, round or flattish, and much twisted, like the coils of a snake, externally dark brown, within red and fleshy. When dried, it has no smell, but a very astringent taste. Roots of plants a few years old should be taken up in spring or autumn. It consists chiefly of tannin, gallic acid, starch, and oxalate of lime. It was formerly given in diseases of debility accompanied with sanguineous or mucous discharges, and likewise fevers, especially intermittents, for the cure of which it may be combined with gentian, or sweet flag-root. It is to be regretted that an indigenous remedy of such power has fallen into neglect. It can be used in dyeing. The large quantity of starch renders it nutritive. It is cultivated and eaten in Siberia, and other northern countries.

BISTRE, a brown pigment made from the root of different kinds of wood, but that of beech is preferred by some who have given directions for making it. One recipe for preparing it is as follows:—Put the soot of any wood (of beech when it can be procured) into water, in the proportion of two pounds to a gallon, and boil them for half an hour. Then, after the fluid has stood some time to settle, but while it is yet hot, pour off the clearer part from the earthy sediment at the bottom; and if on standing any longer it form another earthy sediment, repeat the same method; but this should be done only while the fluid remains hot. Evaporate the fluid to dryness; and what remains will be good bistre, if the soot was of the proper kind. It is then mixed with a little gum-water and made into small cakes. As a colour it is perfectly permanent.

According to the late Dr. M'Culloch, bistre is a very variable article, and is often unfit for use, and he concluded from his experiments, that this is owing to its too near alliance to tar, and hence the disagreeable gumminess which it frequently possesses. He proposed a process for removing the defects which he pointed out, by preparing it from the pitch of distilled wood. ('Trans. Geol. Soc.' vol. ii. p. 1.)

BISUCCINAMIDE. — *Disuccinamide.* — *Succinamide* — $(C_8H_5NO_4 = N\left\{\begin{matrix}(C_8H_4O_4)''\\H\end{matrix}\right.$. An amide formed by the distillation of succinate of ammonia. [AMIDES.]

BISULPHIDE OF AMYL ($C_{10}H_{11}S_2$). An ethereal liquid, possessing a fetid odour, and consisting of one equivalent of the radical amyl, combined with two equivalents of sulphur. [AMYL.]

BISULPHIDE OF CARBON. [CARBON.]

BISULPHIDE OF ETHYL. [ETHYL.]

BISULPHIDE OF ETHYLENE, *Bisulphide of Etherine* ($C_4H_4S_4$). When chloride of ethylene is digested for some days with an alcoholic solution of bisulphide of carbon, a white powder is formed, which possesses the above composition.

BISULPHISATIDE. [INDIGO.]

BITTER PRINCIPLE. When indigo and some other vegetable products are acted upon by nitric acid a substance is produced, which, before its properties had been accurately examined, was called, on account of its taste, bitter principle. This is now, however, known to be a peculiar acid, and is called carbazotic or nitropicric acid, and will be mentioned hereafter under the former name.

Besides this artificial product, there exist a vast number of vegetables, most or all of which are used in medicine, that contain bitter extractive matter, and from which a peculiar bitter principle may in many cases be separated.

These bitter substances have been little examined chemically, and they doubtless include bodies of very different composition. The following list comprises a number of these substances with the derivation of each:

Absinthin, flowers of Artemisia absinthium.
Aloïn, Aloë spicata.
Bryonin, root of Bryonia alba.
Cathartin, leaves of Cassia lanceolata.
Cetrarin, Cetraria islandica.
Colocynthin, seed-pulp of Cucumis Colocynthis.
Columbin, root of Menispermum palmatum.
Cusparin, bark of Galipea cusparia.
Daphnin, Daphne megereum, &c.
Elaterin, fruit of Momordica elaterium.
Ergotin, Ergot of rye.
Fraxinin, bark of Fraxinus excelsior.
Gentianin, root of Gentiana lutea.
Hesperidin, spongy part of orange rind.
Ilicin, leaves of Ilex aquifolium.
Lactucin, Lactuca sativa, &c.
Liriodendrin, root-bark of Liriodendron tulipifera.
Lupulin, female flowers of Humulus lupulus.
Olivil, gum-resin of Olea Europea.
Olivin, leaves of Olea Europea.
Pichrolichenin, Variolaria amara.

Picrotoxin, Menispermum cocculus
Phyllyrin, bark of Phillyrea media.
Quassiin, wood of Quassia amara.
Scillitin, bulb of Scilla maritima.
Tanacetin, Tanacetum vulgare.
Tanghinin, seeds of Tanghina Madagascariensis.
Xanthopicrin, bark of Xanthoxylon Clava Herculis.

BITTERN. A name given to the mother liquor from which common salt has crystallised by the evaporation of sea-water. It contains much sulphate of magnesia, and is used for the manufacture of that salt.

BITTERS, a collective term applied to those vegetable substances the most prominent sensible quality of which is *bitterness*. "Bitterness," says Dr. Cullen, "is a simple perception that cannot be defined, but must be referred to a matter of experience in which mankind are commonly agreed." It was at one time attempted to refer this quality to an hypothetical principle, which was termed *bitter principle;* but it was soon perceived that substances having a bitter taste were indebted for it to very different sources. In the progress of science this term was limited to such natural non-azotised substances as possessed the general character of *extractive*, which was designated bitter extractive, and subdivided into mild bitter, sharp bitter, and narcotic bitter extractive. More recently, the pure non-azotised substances, to which many plants are indebted for their bitterness, have been obtained separately, and even crystallised, such as gentianine, salicine, &c. But bitterness is not confined to vegetable substances destitute of nitrogen, but is possessed by many alkaloids, into the composition of which nitrogen enters, such as quinia, strychnia, brucia, &c. As some of these constitute valuable medicinal agents, as well as the non-azotised substances, it seems improper to adopt a chemical arrangement of these articles as the foundation of our observations. Any bitter substance taken into the mouth produces instantly a sensation which on the first trial is seldom relished, but to which the taste soon becomes reconciled, so that most persons can continue the use of bitter longer than sweet substances. This impression on the organs of taste seems to have little general effect beyond causing a secretion of saliva in most individuals, and it is not till they reach the stomach that they produce much effect. Upon the mucous membrane and muscular fibres of the stomach, as well as upon the neighbouring glands associated with it in the function of digestion, especially the liver and pancreas, they produce a very decided effect. Gummy matter, which forms a considerable portion of most vegetable food, does not easily submit to the action of the digestive organs, but frequently passes through the intestines very little changed. But when associated with bitter extractive it is soon digested, and yields a large quantity of nourishment. Saccharine matter or sugar is not, when existing alone in vegetable food, adequate to the support of the animals which feed upon it, but they become plump and healthy if any bitter matter exist in the plants along with the sugar, or if they have access to other plants almost exclusively bitter, to which they eagerly resort. Where there is a deficiency of bitter matter, and the food is of a very watery kind, such as grows in wet pastures, the cattle suffer from various diseases, especially from the rot.

That bitters develop and heighten the vitality of the stomach seems clear, and in popular language they are called *stomachics*. But they also cause an increased secretion of the juices of the stomach essential to digestion, and also of the bile and pancreatic juice. The secretions are also improved in quality, and when previously excessive may even be diminished in quantity, as a greater degree of firmness and tone is imparted to the whole intestinal canal, by which hasty and imperfect secretion is prevented. The beneficial effects of this improved condition of the stomach are extended to the rest of the system by two means, the first, sympathy, which is speedy in its action; the second, more slow, being the result of the improved blood obtained from better digestion being distributed through the system. The nature of sympathy is little understood, but the effects of that disposition or consent of parts to act in concert or harmony, which physiologists have agreed to term sympathy, are sufficiently manifest. The stomach has been called the centre of sympathy, from its influence upon every organ of the body, and of most organs of the body upon it, according to their respective condition. But by a well-ascertained law of the system the sympathies of the stomach are greatest with those parts the constituents of which are similar to its own: hence mucous surfaces and the muscular fibres throughout the whole body participate in its changes more extensively than other parts. Hence by improving the state of the stomach and intestinal canal every muscle and every artery, for they as well as the heart are muscular tubes, acquire an increased tone, by which the elasticity and energy of the system is greatly augmented. By the improved digestion of the food, a better kind of blood containing more fibrine and red particles is circulated, and conveyed to every part of the body, by which not only better materials are supplied to the glands, out of which to form the secretions, but from which a firmer and better flesh is deposited; and thus the individual finds his strength much increased. The nervous system likewise partakes of the benefit, and the mind is in general clear and active.

Such being the common effect of the use of bitters, some writers regard them as synonymous with tonics; but as all tonic medicines are

not bitter, such, for example, as arsenic, this view cannot be taken, though many of the most valuable tonics are bitter. They have this property in common with most tonics: that their continued use seems to impair the power of the stomach, and leave it in a state of greater weakness than at first. Hence their employment should only be temporary, to raise the powers of digestion when they have been enfeebled by previous disease or excessive fatigue. There exists another reason for caution in their use: they have a great tendency to increase the quantity of blood, both by augmenting the appetite, owing to which more food is taken, and from which a more nutritive and stimulating chyle is extracted, by which a plethoric state of the blood-vessels is induced, and all the attendant evils brought about. These cautionary remarks apply as well to malt liquors as to those bitters unassociated with any nutritive matter which are only employed as medicines. The full and often bloated habit of body of those who daily consume a large portion of strong ale or porter sufficiently demonstrates the consequences of such indulgences. Besides, hops possess, like many other bitters, more or less of a narcotic principle, so that the purest beer produces an injurious effect on the brain, if taken in considerable quantity. The sleepiness which follows its use shows this, as well as the fate of those who are addicted to it. "In seven cases out of ten, malt-liquor drunkards die of apoplexy or palsy." A very moderate use, during dinner, of a beer not containing so much nutritious matter, or too much hop, is allowable to most persons, but it should be thoroughly fermented and purified, and not be hard or stale.

Persons naturally of a full habit of body should carefully avoid the stronger ales and porters. These remarks do not apply to the medical employment of strong ales as a tonic or restorative during convalescence from acute diseases, as few agents so speedily recruit the exhausted powers, or replace the wasted flesh of the sufferer. Neither are they intended to prohibit mothers while nursing from making a moderate use of them, since at that time there is a demand upon the system for an extraordinary quantity of highly nutritive blood, and the infant generally removes any superfluous quantity; but an excessive use of very strong beer is not less hurtful to the mother than the child.

Bitters may be advantageously employed by the inhabitants of cold and damp regions to prevent the action of these causes of disease. These agents generally injure the function of digestion, both by their immediate action on the skin, and also, from abstracting the animal heat, on the nervous system: hence the prevalence of intermittent fevers or agues in such districts. Now these may be warded off by maintaining a healthy action of the digestive organs and of the skin. Some preparation of a pure bitter, such as gentian, or of an aromatic and bitter united, such as chamomile with sweet flag-root, or infusion of milfoil or yarrow, may be had recourse to for this purpose; but if there be obstruction of the liver with ague-cake, which is the enlarged and hardened spleen, dandelion, having beef-tea poured upon it, and used as a soup, is preferable, in which way it is extensively employed by the Dutch. In the West Indies, where languor of the system, with weakness of the digestive organs, is produced by the excessive heat, the appetite is restored and the stomach invigorated by taking before dinner a few drops in a glass of water, of Stoughton's elixir, which is made of gentian, serpentaria, orange-peel, and sweet flag-root; and in America, the infusion or tincture of serpentaria is sometimes taken every morning in damp aguish situations to prevent intermittents. Such employment of bitters, within certain limits, is wise and proper.

During spring and autumn, when the sources of intermittent fevers are most abundant, the use of such bitters as those above mentioned would be very serviceable in the case of weak and feeble persons residing in aguish districts; but there may be weakness of the digestive organs, and general debility, accompanied with a state of stomach which forbids the employment of bitters or any other tonic. Inflammation of the stomach, from its slightest to its most intense degree, is always attended with a sense of weakness, which prompts many persons to betake themselves to bitters or other stimulating articles, which never fail to aggravate the disease. Such cases demand a widely opposite course of treatment.

There is another malady to which feeble persons are subject, the evils of which are much lessened by the use of bitters. Worms are rarely developed except in persons with impaired digestion, in which case bitters form, along with proper dietetical means, the most appropriate instruments of cure. [ANTHELMINTICS.] Much diversity of opinion exists with respect to the propriety of using bitters by persons subject to gout. Of late years the once famous Portland gout-powder has fallen greatly into disuse, partly because a more certain remedy has been discovered, and partly because one of the charges brought against it had some foundation in truth. It was said to cure the gout, but in a short time to carry off the patient by apoplexy. Now such a result was certainly the indirect effect of this tonic powder; for, as by the immunity from paroxysms of gout, which the use of it for a time conferred upon the patients, they were enabled to indulge their increased appetites, a plethoric state of the system was brought on, which in many cases induced apoplexy, in which disease gout has a tendency to terminate. This powder consisted of serpentaria, gentian, germander, and lesser centaury.

Where the disposition to gout is very strong, some of the most experienced practitioners condemn the use even of ale. Still it must be allowed that many persons who have no disposition to excessive indulgence in the good things of the table, have such slow and troublesome digestion as to render tonic and aromatic stimulants useful; but it is best to unite these with some gentle laxative, by which the plethoric tendency is lessened. For this purpose, orange-peel, rhubarb, and magnesia, united in equal portions, form a fitting combination. Gout and stone in the bladder are so closely allied, and the means which are useful in repelling them are so similar in many instances, that they are naturally treated of together: the origin of both is depraved digestion. In full livers this is accompanied with deficient secretion of urine, and a tendency to the formation of uric acid, by which red gravel is voided. Here bitters with alkalies are eminently useful, such as quassia with lime-water, or colchicum with magnesia. In very feeble persons, and also after the long continuance of the uric acid diathesis, and the irritation of a stone in the bladder, an opposite state prevails, namely, an alkaline state of urine, in which it is excessive in quantity, pale, and on standing some time, becomes covered with an iridescent pellicle, or lets fall a white, generally amorphous sediment. In such a case bitters are extremely useful, especially infusion of quassia with phosphate of iron, or infusion of quassia with nitric acid; the extract of *Arctostaphylos Uva Ursi* (bear-berry).

In phthisis pulmonalis bitters are sometimes of service, such as the bear-berry and the Iceland moss (*Cetraria Islandica*), in which the bitter principle should be retained.

In some cases of diarrhœa, from loss of tone of the intestines, bitters are of the greatest service, provided no inflammatory condition of the mucous membrane exist, such as quinia, infusion of cusparia, or even strychnia, perhaps the most intensely bitter substance with which we are acquainted.

The most eligible form for exhibiting bitters is in powder or infusion, but where the taste is objected to, an extract may be given formed into pill. Decoction is a bad form, especially for aromatic bitters. Aromatic principles frequently conceal the disagreeable taste of bitters.

BITTERS. Irrespective of the use of bitter plants for medicinal purposes, there are certain beverages known by the name of bitters. In England, the "bitters" of the spirit-shops are made of brandy, orange-peel, gentian, cassia, cloves, or some other spice, sugar and one or two other ingredients. Many beverages known in foreign countries are more or less analogous to these English "bitters." Thus, the Swiss peasants, inhabiting some of the highest Alpine villages, which are almost constantly wrapped in a penetrating mist, use a spirit distilled from gentian, called bitter schnaps. In France a decoction of wormwood, which is called absinthe, is a very favourite drink; and the mint juleps and other mixtures of the citizens of the United States, depend on the same principle, that of acting as gentle tonics, for their general adoption; and the various modes of preparation are merely used in order to avoid the disagreeableness to the taste of the unadulterated bitter.

BITUMEN. The name bitumen is applied to certain naturally occurring solid or viscous hydrocarbons which are usually of a black or brown colour, possess a peculiar somewhat tarry odour, and are fusible at temperatures below a red heat. It is uncertain how bitumen has been formed, some chemists regarding it as a product of the putrefaction of vegetable matter at ordinary temperatures; as the result in fact of a modification of that natural process of decay, which under ordinary circumstances converts woody fibre into peat, lignite, and coal; whilst others contend that it is a product of the destructive distillation of coal occasioned by the exposure of coal-bearing strata to volcanic heat; the latter view derives considerable probability from the fact that analogous substances are produced by the artificial destructive distillation of coal. Deposits of bitumen are met with in England, France, Switzerland, Germany, Russia, Poland, and America. The most remarkable bituminous deposits in this country occur in Derbyshire, where a thin stratum of bitumen is met with immediately underlying the turf of the grass pastures in the mountain limestone district, and encrusted with beautiful crystals of protosulphate of iron. This Derbyshire bitumen is elastic like caoutchouc, it is soluble in naphtha and essential oils, and when submitted to a red heat, yields a large quantity of highly illuminating gas. Although a considerable quantity of it has been stored up in the Derbyshire caverns, it has not yet been applied to any useful purpose.

The experiments of M. Boussingault show that glutinous and elastic bitumens consist of two principles, one of which he calls *Asphaltin* [ASPHALT], and the other *Petrolin*; the former is fixed, the latter volatile. Petrolin may be obtained by distilling bitumen with water. Rectified from chloride of calcium, petrolin presents the appearance of a pale yellow oil, possessing a bituminous odour, and a specific gravity of ·891. It boils at 535° Fahr., and has the composition $C_{40}H_{32}$. It is therefore isomeric with oil of turpentine. The harder descriptions of bitumen are undistinguishable from asphalt, and are used for similar purposes; the softer varieties frequently contain paraffin, and might probably be utilised for the extraction of this substance.

BITUMENS, MEDICAL USES OF. Though the substances popularly termed bitumens, in the most extensive use of the term,

differ, as stated above, yet as in medical writings the term is restricted to certain forms of these, a slight notice of their uses and modes of action may here be most appropriately introduced. In this limited sense bitumens comprise naphtha, petroleum, and asphaltum, which are all transition states of the same thing, from naphtha the most fluid, to asphaltum the most solid. These appear to be all mixtures in different proportions of naphtha (strictly called *naphtha montana*), paraffine, creosote, acetic acid, and of some substance which easily becomes black by the action of the air. The chief constituent principles are carbon and hydrogen. They may be considered mineral empyreumatic oils, and in their action on the human system they are similar to balsams and resins. Their sphere of action does not seem to extend beyond the spinal chord and ganglionic system; they do not affect the brain or its nerves, except indirectly in case of an overdose, through the vitiated and imperfectly carbonised blood. The functions dependent for their perfection on the nerves of organic life are more powerfully affected by these agents than by any other empyreumatic oil. The secretions of the mucous membranes, of serous membranes, and glandular structures, as well as the skin, are promoted by their influence. The process of absorption is also increased, and a more copious secretion of urine takes place. They are better suited for slight and chronic affections of the nerves of organic life, than for acute or violent disorders of them. They have been employed in loss of power, cramps, and chronic affections of a nervous but obscure nature; also in affections of the mucous membranes of the lungs, when balsamic medicines are proper, such as humid catarrh, and some of the forms of asthma arising from nervous debility. Likewise in similar states of the bladder, such as atony of that organ, loss of power of its sphincter muscle, catarrhus vesicæ, &c. They have also been used in gouty and rheumatic affections, especially when these threaten to terminate in stiffness or loss of power. Lastly, they have been employed as a remedy against worms, especially the tape-worm, in which their efficacy is increased by combination with asafœtida. Externally they are used as embrocations in rheumatic and gouty affections, and also to allay cramps and spasms. They are also serviceable as an external application to chilblains, and some other ulcers resulting from an imperfect circulation and low degree of nervous power.

Their employment would be very improper during any inflammatory state of the system, or increased sensibility of the nerves. An overdose is decidedly poisonous, causing general excitement, tremblings of the limbs, cramps, convulsions, laborious respiration, a venous state of the blood, great debility, and death: or recovery may take place, if by means of respiration and a copious secretion of bile and urine, the blood can be freed from its excess of carbon. Even after a favourable issue appears likely to occur, death may take place at the end of two or three days. A very large dose may very speedily cause death. [Creasote; Paraffin; Petroleum.]

BIURET. ($C_4H_5N_3O_4$,2 Aq.=HO, NH_4O,2 CyO,2 Aq.) When urea is fused and exposed for some time to a temperature of about 230° Fahr., it evolves a large quantity of ammonia and leaves a pasty residue, which nearly dissolves in a very small quantity of boiling water. This solution must be passed through a filter, and then precipitated by subacetate of lead. The precipitate must be separated by filtration and the liquid treated with sulphuretted hydrogen to remove the excess of lead. A final filtration and evaporation yields the biuret in little granular crystals, which may be purified by recrystallisation. Biuret is very soluble in water and in alcohol, and may be detected by an intense red colouration when a few drops of a solution of a salt of copper, followed by a slight excess of potash, are added to its solution. It stands in the same relation to bicyanate of ammonia, as urea does to cyanate of ammonia. Heated until it fuses, it is converted into cyanuric acid and ammonia.

$$3(C_4H_5N_3O_4) = 2(\underbrace{C_6H_3N_3O_6}) + 3NH_3$$

Cyanuric Acid.

BIVOUAC (written also BIHOUAC, BIOUAC), is a term in military tactics probably derived from the German verb *bewachen*, or *beywachen*, signifying to watch over: it was originally applied to the strong parties of cavalry which were posted beyond the lines of intrenchment in order to watch the motions of the enemy, and prevent any attempt to take the army by surprise; and, because the soldiers thus employed passed the night in the open air, the term was subsequently used to denote the condition of any body of troops when in the field, and not regularly encamped under tents.

Formerly, no army served during a campaign without being well provided with every material necessary for its protection from the inclemency of the weather; but, during the wars of the Revolution, the French soldiers, except on a few occasions, dispensed with tents. At the periods in which military operations were suspended, they were quartered in towns and villages; and while on active service, they had only the occasional cover afforded by such buildings as happened to be situated in the district which they occupied. In all their great expeditions they remained *au bivouac*, as it was called; and the rapidity of their movements was due, in a great measure, to their freedom from the *impedimenta* with which armies were formerly encumbered. The important successes which so long attended the armies of France were, no doubt, the cause of their example, in this respect, being followed by their opponents.

The carriage of an extensive tent equipage is necessarily attended with serious inconvenience on any change of position; but the removal of this evil must be accomplished, more or less, at the expense of the comfort and health of the soldier. During the summer season, and in the south of Europe, it may be indifferent whether or not the men pass the night under a roof; and indeed in those climates and in the summer season the open air may be preferred; but the cold winds and rains which are so frequently experienced in the spring and autumn in northern climates must induce painful and dangerous diseases, which render the men at an early period of their service unfit for the active duties of war. The French troops are now equipped with *tentes abris;* each tent, which is large enough to afford cover for two men lying down, consists of two pieces of canvas and two small poles, which are carried by the men strapped on to their knapsacks. On camping, these are soon set up, and the men, crawling into them to sleep, are protected from the dew and night-air.

Generally, in a bivouac, fires are kept up during the night with wood obtained from the neighbouring forests or villages: the arms being piled along the line, the troops place themselves in their rear in groups, each about its proper fire, which is lighted in any convenient situation, the men sitting or lying upon straw if it can be procured, and endeavouring to shelter themselves from wind or rain by means of boughs planted in the ground, or by boards formed into a roof, according to circumstances. The bivouac fires of an army often afford a means of arriving at an approximate estimate of its strength, by counting the number of fires, and allowing ten or twelve men to each. The bivouac of an army making a rapid retreat before an enemy is that in which the most disastrous consequences follow, both to the soldier and to the people of the country along the line of march; a complete disorganisation of the army too often takes place, and lamentable excesses are committed by men suffering the severest distresses from hunger and fatigue. The retreat of the French army from Moscow will be for ever remembered as an example exhibiting every species of misery which can be inflicted and suffered under the consequences of a rash and unfortunate expedition.

When a position is to be occupied for several days, it may happen that the men find means to construct rude huts for their protection with such materials as are at hand; and, in an extremely inclement season, they are usually cantoned in such towns or villages as are in their neighbourhood. They then light their fires in the streets, in gardens, or in barns; certain spots having been previously appointed as alarm posts, about which, on signals being given, the different corps may assemble, in order to form the line of battle, and act immediately as circumstances may require. Permanent cantonments for the winter are of this nature, and they are secured against surprise by outposts constantly maintained at proper distances about them.

BIXIN. ($C_{16}H_{13}O_2$). The red colouring principle of arnotto. It dissolves in alkaline solutions, and is again precipitated by acids as an orange powder. It is sparingly soluble in water, but easily so in alcohol and in ether. [Arnotto.]

BLACK. [Light.]

BLACK ASH. [Soda Ash.]

BLACK ASSIZE, the name given to a fatal assize held in 1577 in the old town-hall of Oxford, situated at that time in the yard of the castle. Holinshed, Stow, and Baker make particular mention of it in their 'Chronicles;' but the best account of it is in Anthony à Wood's 'History and Antiquities of the University,' published by Gutch, 4to, Oxford, 1796, vol. ii. p. 188; where noticing the trial of one Rowland Jencks, a bookbinder, for sedition, he says: "The assizes therefore being come, which began the 4th of July, and continued two days after in the court-house at the castle-yard, the said Jencks was arraigned and condemned in the presence of a great number of people to lose his ears. Judgment being passed, and the prisoner taken away, there arose such an infectious damp or breath among the people, that many there present, to the apprehensions of most men, were then smothered, and others so deeply infected that they lived not many hours after. The persons that then died," he adds, "and were infected by the said damp, when sentence was passed, were, Sir Robert Bell, baron of the Exchequer; Sir Nicholas Barham, sergeant-at-law; Sir Robert d'Oyley, the high sheriff; Hart, his under sheriff; Sir William Babyngton, Robert d'Oyley, Wenman, Danvers, Fetiplace, and Harcourt, justices of the peace; Kerle, Greenwood, Nash, and Forster, gentlemen; besides most of the jury, with many others that died within a day or two after. Above 600 sickened in one night, as a physician of Oxford (Georg. Edrycus in 'Hypomnematibus suis in aliquot libros Pauli Æginetæ,' edit. Lond. 1588, lib. 2) attested; and the day after, the infectious air being carried into the next villages, there sickened 100 more. The 15th, 16th, and 17th days of July sickened also above 300 persons, and within twelve days' space died 100 scholars, besides many citizens. The number of persons that died in five weeks' space—namely, from the 6th of July to the 12th of August (for no longer did this violent infection continue)—were 300 in Oxford, and 200 and odd in other places; so that the whole number that died in that time were 510 persons, of whom many bled till they expired. Some," Wood says, "left their beds, occasioned by the rage of their disease and pain, and would beat their keepers or nurses, and drive

them from their presence. Others ran about the streets and lanes in a state of phrenzy, and some even leaped headlong into deep waters. The physicians fled, not to avoid trouble," he says, "but to save themselves and theirs." The heads of houses and doctors almost all fled; and there was not a single college or hall but had some taken away by this infection. "The parties," Wood says, "that were taken away by this disease were troubled with a most vehement pain of the head and stomach, vexed with the phrenzy, deprived of their understanding, memory, sight, hearing, &c. The disease also increasing, they could neither eat nor sleep, nor would suffer any attendants to come near to them. At the time of their death they would be very strong and vigorous; but if they escaped it, then they were to the contrary. It spared no complexion or constitution, and the choleric it chiefly molested. That which is most to be admired is, that no women were taken away by it, or poor people, or such that administered physic, or any that came to visit. But as the physicians were ignorant of the causes, so also of the cures of this disease." Holinshed says that no child died of this infection. Baker says that Jencks was a bookseller, and was "questioned for speaking opprobrious words against the queen." He makes the deaths considerably below this statement, mentioning most of the eminent persons named by Wood, and "300 others, more or less." He also attributes it either "to the noisome smell of the prisoners, or from the damp of the ground."

It seems more than probable that the distemper which arose on this occasion, was a fever originating in the poisonous condition of the adjoining gaol, where the prisoners had been long close and nastily kept. Wood mentions a similar event at Cambridge, at the assizes held in the castle there in the time of Lent, 13 Henry VIII., A.D. 1521, where the justices, all the gentlemen, bailiffs, and most who resorted thither, took such an infection, that many of them died, and all almost that were present sickened, and narrowly escaped with their lives.

Father Sanders (in his book 'De Schismate Angl.,' lib. iii), noticing the black assize of Oxford, called it "ingens miraculum," and ascribed it as a just judgment on the cruelty of the judge for sentencing the bookbinder to lose his ears.

A contemporary account of the black assize is given in a letter from Sergeant Fleetwood, recorder of London, to Lord Burleigh, dated 30th July, 1577, printed in Ellis's 'Original Letters Illustrative of English History' (second series, vol. iii. p. 54); and another contemporary account, in Latin, from the Register of Merton College, was communicated to the Royal Society by Professor Ward in 1758, and is printed in the 'Philosophical Transactions' for that year, vol. l. part ii. p. 699.

(See also Holinshed's 'Chron.,' vol. ii.; Stow's 'Annals;' and Pointer's 'Antiquities and Curiosities of Oxford,' 8vo, Lond., 1749.)

BLACK FLUX. A mixture of finely divided carbon with carbonate of potash. It is prepared by igniting bitartrate of potash (cream of tartar) mixed with half its weight of nitrate of potash, in a covered crucible until all volatile matter is expelled. As it is deliquescent it should be preserved in well stopped bottles. It is used for the reduction of metals on a small scale. [ARSENIC, DETECTION OF].

BLACK, or DOMINICAN, FRIARS, one of the four orders of mendicants whose founder was St. Dominic, a Spaniard, born at Calahorra, or Calaruega, a small town in the diocese of Osma, in Old Castile, about 1170. [DOMINIC, SAINT, BIOG. DIV.]

These friars were called Dominicans from their founder; Preaching Friars, from their office to preach and convert Jews and heretics (see 'Lit. Pat.' 8 Edw. I. m. 23; and 14 Edw. II. p. 1, m. 16); Black Friars from their garments; and, in France, Jacobins, from having their first house in that country in the Rue St. Jacques at Paris.

Their rule, which was chiefly that of St. Augustine, was approved by Pope Innocent III. in the Lateran Council, 1215, by word of mouth, and by a bull from Pope Honorius III. in 1216; but as they gathered power, even in Dominic's life-time, it was provided that the choice of the general of the order, as well as of the provincials, should vest in the order, and not depend on the pope, and that a general chapter should be held annually at Bologna and at Paris interchangeably. They were known, however, earlier than 1216; for Rymer in his 'Fœdera,' tom. i. p. 137, has printed a licence or permission addressed from Pope Innocent III. to King John of England, in 1204, for such Dominicans and Franciscans, who might accompany the king in going beyond sea, to ride, the rules of their order obliging them to travel on foot.

Thirteen of these Dominican friars, according to Reyner ('Apostolat. Benedictin. in Angl.' tom. i. p. 161), including a superior, came into England in 1221, for the purpose of establishing their order in England; when Stephen Langton, then archbishop of Canterbury, giving his approval, they were allowed to settle, and fixed their first house at Oxford in that year. (Reyner, ut supr.; see also Wood's 'Hist. of Oxford,' p. 62; N. Triveti, 'Chron.' p. 176.) The Black Friars at London was their second house: originally placed near where Lincoln's Inn now stands, but removed about 1279 to some place near Castle Baynard, where the parochial district still bears the name of the order.

In 1232, after having had much contention with the Franciscans, the management of the Inquisition was deputed to the order by Pope Gregory IX., a weapon which was not allowed to rest idle in their hands, and which, under Torquemada and others, occasioned a fearful amount of suffering in the New World as well as the Old. [INQUISITION.] The rule of the order forbidding them to hold any landed property was repealed in 1425 by Pope Martin V., and they very soon became one of the most richly endowed of all the orders. Chaucer, as well as other of the early English writers, have indulged themselves in satirising the excesses of the friars, without always distinguishing the order.

At the time of the dissolution of the monasteries under Henry VIII. there were fifty-eight houses of Dominicans in England and Wales. Tanner, who did not find them all out, reckoned the English houses only at forty-three.

Tanner says, "There were nuns also of this order, but I think none in England; for, though Thomas Lord Wake intended to have brought some of them hither, and had the king's licence for it, yet he seems not to have done it." ('Notit. Monast.' ut supr.) The nuns of Dartford in Kent, however, are believed to have been for some time of this order. King Edward III., in his letter to the Bishop of Rochester, concerning his intended foundation of that house, calls it "une Maison des soeres de l'Ordre de Precheurs.") See Thorpe's 'Registrum Roffense,' p. 312.)

Stevens has given an elaborate account of the origin of the Dominican order, from the 'Histoire des Ordres Monastiques,' already quoted, followed by a catalogue of the most celebrated men of English birth among the Black Friars who were writers. Amongst these, Robert Kilwarby, afterwards archbishop of Canterbury and a cardinal of the Roman Church, who died in 1280; Nicholas Trivet, the historian, who died in 1328; and Robert Holcot, who died in 1349, are the most distinguished. There were also many learned Dominican foreign writers, and the order produced many celebrated painters and sculptors. Among the painters may be especially mentioned Giovanni da Fiesole, called Fra Angelico, and Baccio della Porta, better known as Fra Bartolomeo.

BLACK JACK. [ZINC.]

BLACK LEAD. [CARBON; PLUMBAGO.]

BLACK-LEAD PENCILS. [PENCILS; PLUMBAGO.]

BLACK PIGMENTS. [CARBON; CHARCOAL, ANIMAL.]

BLACK ROD, USHER OF THE, is an officer of the House of Lords. He is styled the Gentleman Usher of the Black Rod, and is appointed by letters-patent. His deputy is styled the Yeoman Usher. They are the official messengers of the Lords; and either the Gentleman or the Yeoman Usher summons the Commons to the House of Lords, when the royal assent is given to bills. It is part of his duty to take into custody parties guilty of a breach of privilege or of a contempt, and he assists at the introduction of peers and other ceremonies. One of the officers of the Legislative Council of Nova Scotia is styled Gentleman Usher of the Black Rod.

BLADDER, DISEASES OF. The bladder, like every other organ of the body, is liable to inflammation. This disease is called *Cystitis*. When present there is pain and tenderness in the region of the bladder, also in the region of the perineum and sacrum, and along the urethra. The urine passed is clouded with mucus, and afterwards contains pus often mixed with blood. These local symptoms are accompanied with general fever. The inflammation may extend from the bladder to the peritoneum.

This disease may come on after the operations of lithotomy or lithotripsy, or other direct injury. It may be the result of specific inflammation of the urethra, extending to the bladder, or it may come on from irritating medicines acting on the bladder, as cantharides.

In its treatment antiphlogistic remedies of an active kind are needed, such as bleeding generally and locally, antimony, calomel, and opium. Opium should be given by the mouth and per anum for the purpose of relieving the pain. The bowels should be opened by enemata and gentle purgatives; and the recumbent position must be absolutely enjoined.

Cystitis may become chronic, or a chronic inflammation of the bladder may be produced by irritation in neighbouring organs, as in the urethra, rectum, or kidneys. There is pain in the bladder, frequent micturition, and mucus in the urine. The mucous membrane of the bladder may ulcerate, and the urine is mixed with blood and pus. The ulceration may extend through the bladder to the surrounding organs. In the treatment of this disease, the obvious cause must be removed. Opium for the pain, a generous diet, astringent infusions, as of buchu, and mineral acids, are principally recommended. Iron is sometimes of great use, also copaiba. Counter-irritation on the hypogastrium, or over the sacrum, should not be neglected. In very chronic cases it has been recommended to wash out the bladder with warm water by means of a double catheter. Lallemand recommends the direct application of the nitrate of silver.

Irritable Bladder.—A state of the bladder is recognised in which there is no inflammatory action, but in which the symptoms resemble those of cystitis. There is frequent micturition, uneasiness in and about the region of the bladder. The urine is mostly limpid and clear. This state depends on some derangement of the kidneys or general health, or it may come on from piles, stone in the bladder, or threadworms.

In treating this state the great thing to be done is the removal of any observed cause. Where it comes on in a generally decayed state of the health, the treatment must be directed to this condition of the system.

Hæmaturia.—Blood in the urine may present itself when the

kidneys, bladder, or urethra are affected. When it arises from the kidneys the blood presents itself in the form of small tubular cysts, produced in the tubules of the kidneys. When the bladder is the seat of stone, cystitis, or malignant tumours, bloody urine makes its appearance. When the hæmorrhage proceeds from the urethra, the blood passes away independent of the urine. In these cases the cause of the hæmaturia must be treated.

Incontinence of Urine or Enuresis. This disease presents itself in two classes of cases, in children, and in adults. The first is a very common and troublesome disease. The urine is usually passed voluntarily during the day, but in the night it passes away involuntarily. Although frequently treated as though it were a bad habit, it is the result of a morbid state of the system, which must be removed, and the will should only be called into exercise to assist a judicious system of treatment. All causes of general debility should be removed. Sea air, cold sea-bathing, with the administration of iron, especially the tincture of the sesquichloride, are the most appropriate remedies for the want of tone of the nervous system which accompanies this disease. Strychnine has been recommended. The child should not lie on its back, and it should be awakened in the night, at stated intervals, to pass the urine voluntarily. Mechanical remedies are to be condemned.

In the incontinence of adults, either the urine passes away from previous retention, or, as happens in aged people, the bladder loses its tone, and both its expulsive and retentive powers are feeble or gone. In the first case the catheter must be employed to empty the bladder, and the retention treated. In the other case, tonics and other remedies necessary for the debilitated state of the system must be employed. Generally, however, little can be done, and cleanliness and the use of urinals are the only means left.

Retention of Urine. This arises from various causes, and the treatment must vary accordingly. The symptoms in all cases are, an inability to evacuate the urine, whilst the desire to do so is constant and frequently accompanied with pain, straining, and distress. The bladder is distinctly felt to be distended above the pubes, there is dullness on percussion there, and pressure produces great pain. Sickness is frequently present, the pulse becomes rapid, the skin hot, and at last symptoms of the absorption of the urine present themselves, and unless relieved, the patient dies from the blood becoming poisoned by the urea of the urine. All these symptoms are removed by the removal of the urine. This may frequently be done by the catheter, but the disease can only be cured by the removal of the cause.

The following are enumerated as causes of this disease. Stricture of the urethra. Inflammation of the urethra. Irritation and spasm of the neck of the bladder. Priapism. Abscess in the perineum. Abscess in the pelvis. Calculus in the urethra. Injury of the perineum. Paralysis. Diseased prostate. Blood in the bladder. Malignant disease of the bladder or urethra. Imperforate urethra. In each of these cases a special treatment is necessary, but in all it should be remembered that fatal results will occur unless the distended viscus is emptied of its contents. It often happens that for this purpose the catheter cannot be passed into the urethra; under these circumstances, the only means left is to puncture the bladder. This operation may be performed from the perineum, the rectum, and the pubes. In puncturing the bladder from the perineum, an operation is performed similar to that for lithotomy. [LITHOTOMY.] When this operation is deemed unadvisable, the bladder may be reached from the rectum and punctured here. It is only when these two methods are found to be impracticable, that puncturing the bladder through the parietes of the abdomen in the region of the pubes is had recourse to. These operations are not often performed: "but any one of them is much preferable at any time to postponement of relief, and consequent disaster by extravasation; and all, too, are preferable to pushing a metallic catheter by sheer force through an impassably strictured urethra." (Miller.)

Diseases of the Prostate. The prostate gland is liable to the various diseases of other parts of the urinary organ. It may be inflamed, or abscess may occur in it, or it may be subject to malignant disease. It is, however, most liable to *enlargement* or hypertrophy, which is one of the most troublesome and frequent diseases to which old age is liable.

Enlargement of the prostate is of two kinds. One is the result of inflammatory action, and the other is an enlargement independent of that process. The first is only temporary, and may be frequently speedily removed by treatment. It is the result of stricture, gleet, affection of the rectum, or injury to the perineum in riding. Leeches, purgatives, the recumbent position, and counter-irritants, are the proper treatment. The second form of enlarged prostate is more difficult to manage. It is one of the consequences of increasing age. The enlargement in these cases may be partial or general. One of the most painful consequences of either is a difficulty in passing the water. This comes on gradually, and is also attended with difficulty in emptying the rectum, as this organ is pressed on by the distended prostate. As the tumour enlarges, the calls to empty the bladder are more frequent, and the act is less perfectly accomplished, and a portion of residuary urine remains in the bladder behind the enlargement. Under these circumstances the bladder becomes irritable, and chronic cystitis is established. The symptoms of this disease are then added to those of the enlarged prostate.

There is no cure for this state of things, and the treatment is consequently palliative. Much, however, may be done for the comfort of the patient. All excess and imprudence in diet and exercise must be avoided. The recumbent position must be maintained as much as possible. The bowels regulated by enemata and gentle aperients. Opium, iron, mineral acids, and buchu, may be given according to circumstances. In order to prevent distension, the catheter must be had recourse to, and the water drawn off occasionally.

BLADDERS, when brought to a clean and prepared state, are especially useful to druggists, oilmen, colourmen, and manufacturers, as coverings for various kinds of vessels. They derive their value from the thinness, toughness, and impermeability to water possessed by their substance. The bladders of the ox and other animals, when deprived of bits of loose membrane and other impurities, are washed in a weak solution of chloride of lime; they are then rinsed in clean water; then blown out, and submitted to pressure by rolling them under the arm, which stretches and enlarges hem. They are finally blown out quite tight, fastened, and dried.

BLANK VERSE has been defined to be verse without rhymes, or the consonance of final syllables. Johnson, in his 'Dictionary,' says it means, "where the rhyme is blanched, or missed." But this, in the modern sense of blank verse, is far too indefinite, as it would include all unrhymed verse, such as Collins's 'Ode to Evening,' Southey's 'Thalaba,' and Longfellow's 'Hiawatha.' The term is now, and indeed has been from the beginning, used to distinguish the heroic line of ten syllables, without rhymes. All the verse of the ancient Greeks and Romans that has come down to us is unrhymed; but during the Middle Ages, rhyme, however it originated, came to be employed as a common ornament of poetical composition, both in Latin and in the vernacular tongues of most of the modern nations of Europe. In the 15th century, when a recurrence to classical models became the fashion, attempts were made in various languages to reject rhyme, as a relic of barbarism. Thus, Homer's 'Odyssey' was translated into Spanish blank verse by Gonsalvo Perez, the secretary of state to the Emperor Charles V., and afterwards to Philip II. Warton, in his 'History of English Poetry,' observes also that Felice Figliucci, in his admirable Italian commentary on the ethics of Aristotle, entitled 'Filosofia Morale sopra i libri dell' Ethica d' Aristotile,' not only declaims against the barbarity of rhyme, and strongly recommends a total rejection of this Gothic ornament to his countrymen, but enforces his precept by his own example, and translates all Aristotle's quotations from Homer and Euripides into verse without rhyme. Figliucci's commentary was published in 1551. Warton afterwards observes: "In the year 1528 Trissino published his 'Italia Liberata di Goti,' or 'Italy Delivered from the Goths,' an heroic poem professedly written in imitation of the 'Iliad,' without either rhyme or the usual machineries of the Gothic romance. Trissino's design was to destroy the *terza rima* of Dante. We do not, however, find, whether it be from the facility with which the Italian tongue falls into rhyme, or that the best and established Italian poets wrote in the stanza, that these efforts to restore blank verse produced any lasting effects in the progress of the Italian poetry." This statement is allowed to stand uncorrected in the last edition of Warton; but in fact Trissino's poem was not published till it appeared in three volumes, the first printed at Rome in 1547, and the second and third at Venice in 1548. (See De Bure, 'Bibliographie Instructive,' iii. 678, 679.) The 'Italia Liberata' is stated by the biographers of Trissino to have been begun in 1525. Another work in blank verse by the same writer, however, his tragedy of 'Sophonisba,' celebrated as the first regular tragedy which appeared in the Italian language, was printed in 1524. (See the catalogue at the end of Riccoboni's 'Histoire du Théâtre Italien.') It was first represented at Rome in 1515. In 1516 the tragedy of 'Rosmunda,' also in blank verse, by Trissino's friend, Rucellai, was recited at Florence in the presence of Pope Leo X., and was printed at Sienna in 1525. In a work entitled an 'Historical Memoir on Italian Tragedy,' by Joseph Cooper Walker (4to. Lond. 1799), there is a short paper on the origin of blank verse in the Italian language (Appendix, No. 3, pp. xx.—xxiii.), in which the author observes that Trissino, though the first Italian writer who used blank verse in long works, and accordingly recognised both by his contemporaries and his countrymen generally as the first who introduced it into their poetry, is not, strictly speaking, to be considered as its inventor. Not to speak of the occasional specimens of blank verse which are to be found interspersed in the works of Boccaccio and his contemporaries, there is a blank verse poem called the 'Cantico del Sole,' written by St. Francis, the founder of the Franciscans, in the beginning of the 13th century. This poem, however, it seems, was thought to be in prose till its metrical character was detected by the critic Crescimbeni in his 'Istoria della Volgar Poesia,' a work published towards the end of the 17th century.

In the French language, in like manner, various writers have one after another attempted to write verse without rhyme. Among those who are said to have composed in this fashion are Jodelle and De Baif, who were two of the celebrated Pleiad of poets that adorned the age of Francis I. and Charles IX. (See Pasquier, 'Recherches sur la France,' liv. vii. chap. xii.; and Baillet, 'Jugemens des Savans,' tom. iv. pp. 94 and 124, edit. of 1725.) Afterwards Nicholas Rapin, who lived in the reign of Henry IV., repeated the same attempt, and, in the opinion of the Cardinal du Perron, with more success than De Baif. (See Baillet, tom. iv. p. 155.) Still more recently French blank verse was written

by De la Motte le Vayer, in the age of Louis XIV. None of these attempts, however, have had the effect of reconciling the French ear to this mode of composition, and it is probable that there is something adverse to it in the genius of the language.

The first English blank verse ever written appears to have been the Translation of the First and Fourth Books of the Æneid, by Lord Surrey, which was printed in 1557 under the title of 'The Fourth Boke of Virgill, intreeting of the Loue between Æneas and Dido; translated into Englishe, and drawen into straunge metre,' Lond. without date, 4to, 1557, along with the second book, but which must have been written at least ten years before, for Surrey was executed in 1547. Surrey most probably borrowed the idea of this innovation from the Italians; but Dr. Nott is of opinion that he could not have seen Trissino's poem, already mentioned, as it was not printed till after his death, though written many years before. Ascham, in his 'Schoolmaster,' expressly commemorates this translation of Surrey's as the first attempt to write English verse without rhyme. "The noble Lord Thomas, earl of Surrey," he says, "first of all Englishmen, in translating the fourth book of Virgil, and Gonzalvo Perez, that excellent learned man, and secretary to King Philip of Spain, in translating the Ulysses of Homer out of Greek into Spanish, have both by good judgment avoided the fault of rhyming." "The spying," he adds, "of this fault now is not the curiosity of English eyes, but even the good judgment also of the best that write in these days in Italy." The first who imitated Surrey in the new kind of verse which he had introduced was, according to Warton, Nicholas Grimoald, or Grimalde, some of whose poetical compositions were first printed in the same volume in which Surrey's translation from Virgil appeared. "To the style of blank verse exhibited by Surrey," says Warton, "he added new strength, elegance, and modulation. In the disposition and conduct of his cadences, he often approaches to the legitimate structure of the improved blank verse." The next thirty years may be said to have naturalised the new mode of versification in the language. The first theatrical piece which appeared in blank verse was Lord Sackville's tragedy of 'Gorboduc,' otherwise called the tragedy of 'Ferrex and Porrex,' which was acted in the hall of the Inner Temple in 1561, though not printed till 1565. Then followed George Gascoigne's tragedy of 'Jocasta,' which was acted at Gray's Inn in 1566. In 1576 the same author published a poem in blank verse, entitled 'Steel Glass.' In 1579 appeared George Peele's blank verse tragedy of 'David and Bethsabe.' In 1588 was published Aske's poem, in the same form of versification, entitled 'Elizabetha Triumphans.' 'A Tale of Two Swans,' a blank verse poem by William Vallans, appeared in 1590; and 'Hieronymo,' another tragedy without rhyme, had also been acted before that year. So that when Shakspere began to write for the stage, as he is supposed to have done in 1591, he may be said to have found blank verse already familiar to the public ear as the legitimate form of dramatic poetry. (See Warton's 'History of English Poetry,' section xl., and the notes to the edition of 1824. See also section x. of the Dissertation by Dr. Nott on 'The State of English Poetry before the Sixteenth Century,' prefixed to his edition of Surrey's Poems, 1815.)

It is curious that Sir Philip Sidney does not mention blank verse in his treatise entitled 'The Defence of Poesy,' which must have been written after several of the pieces we have mentioned above had appeared. Sidney died in 1586, at the age of thirty-two. "Now of versifying," he says, "there are two sorts, the one *ancient*, the other *modern*: the *ancient* marked the quantity of each syllable, and according to that framed his verse; the *modern* observing only number, with some regard of the accent, the chief life of it standeth in that like sounding of the words which we call rhyme." "Truly," he afterwards adds, "the English, before any vulgar language I know, is fit for both sorts;" and then he goes on to show its superiority to the Dutch (that is, the German), the Spanish, the Italian, and the French, resting his argument entirely, in so far as the three last-mentioned tongues are concerned, on its alleged greater variety of final rhymes. In a preceding part of the treatise he expressly mentions the tragedy of 'Gorboduc,' making it an exception to the rudeness of all the English plays he had seen, as being "full of stately speeches and well-sounding phrases, climbing to the height of Seneca his style, and as full of notable morality, which it doth most delightfully teach, and so obtain the very end of poesy."

Notwithstanding the examples thus set, the employment of blank verse was almost confined to the drama for the greater part of the 17th century. Drayton, and Daniel, and Phineas Fletcher, and Davenant, all in that interval wrote long poems, and all in rhyme. Even dramatic composition had, after the Restoration, in the hands of Dryden and others, begun to revert to that form. Dryden, in his 'Essay on Dramatic Poetry,' published in 1663, discussed the relative advantages of blank verse (which he says the French call *prose mesurée*) and rhyme, giving the preference on the whole to rhyme; but he acknowledges that the majority of the public was in favour of blank verse, and adds, in his 'Epistle Dedicatory to the Rival Ladies,' that it is a measure "into which the English tongue so naturally slides, that in writing prose it is hardly to be avoided." At length in 1667 appeared the 'Paradise Lost,' and vindicated the capabilities of blank verse by the noblest exemplification of it the language yet possesses. In an advertisement prefixed to the second edition of this poem, printed in 1668, Milton, professing to give "a reason of that which stumbleth many—why the poem rhymes not," says, "The measure is English heroic verse, without rhyme. . . . This neglect of rhyme is so little to be taken for a defect, though it may seem so perhaps to vulgar readers, that it is rather to be esteemed an example set, the first in English, of ancient liberty recovered to heroic poem from the troublesome and modern bondage of rhyming." He allows, however, and indeed urges the fact in vindication of himself, that "some both Italian and Spanish poets of prime note have rejected rhyme both in longer and shorter works, as have also long since our best English tragedies."

For nearly two centuries blank verse may be said to have been recognised as the only legitimate form for the higher species of dramatic composition in our language. "Aristotle observes," says Addison ('Spectator,' No. xxxix.), "that the Iambic verse in the Greek tongue was the most proper for tragedy, because at the same time that it lifted up the discourse from prose, it was that which approached nearer to it than any other kind of verse. For, says he, we may observe that men in ordinary discourse very often speak Iambics without taking notice of it. We may make the same observation of our English blank verse, which often enters into our common discourse, though we do not attend to it, and is such a due medium between rhyme and prose, that it seems wonderfully adapted to tragedy. I am therefore very much offended when I see a play in rhyme; which is as absurd in English, as a tragedy of hexameters would have been in Greek or Latin." Many long moral and descriptive poems, as well as shorter pieces of the same class, have also within this period been composed in blank verse; but here it can only be said to hold a divided empire with rhyme. The attempts that have been made to reject rhyme in our other measures have not removed the feeling in favour of rhyme, in so far as regards the establishment of the principle, however much the beauty of particular poems composed upon that system may have been admired. But some imitations of the classical poets in their own peculiar rhythms have great beauty, such as Milton's translation of Horace's Ode to Pyrrha, Longfellow's 'Evangeline,' in hexameters, and the unrhymed poems we have mentioned at the commencement; and also several successful translations, in hexameters and other unrhymed metres from the German, such as Göthe's 'Hermann und Dorothée,' and many of the lyrics. But these, as we have already said, are not included in what is now understood as blank verse.

The German probably, of all the languages of modern Europe, admits the greatest variety of unrhymed measures. From the practice of modern German poets, it would appear that any species of verse which may be used in that language with rhyme, may also be used without it. In the German translations from Greek and Roman poets we find every species of ancient metre successfully imitated, and of course without rhyme. That which approaches nearest to, or rather is identical with, our ten-syllable blank verse, is also much used, as in the following example:—

> Der blinde Greis erhub sich alsobald,
> Wählt' einen' Text, erklärt' ihn, wandt' ihn an,
> Ermahnte, warnte, strafte, tröstete,
> So herzlich, dass die Thränen mildiglich
> Ihm niederflossen in den grauen Bart.—Kosegarten.

According to Mr. Park, in a note to Warton's 'History of English Poetry,' vol. iv. p. 241, the poet Daniel, in his 'Apology for Rhyme,' published in 1603, appears to designate what we now call blank verse by the expression *single numbers*. The Italians call blank verse *verso sciolto*, that is, loosened or untrammelled verse.

BLANKET. [Woollen and Worsted Manufacture.]

BLANQUININ. An alkaloid, said to have been found by Dr. Mills in white cinchona bark (*Cinchona ovalifolia*). As its composition was not determined, its existence is very problematical. The substance found was probably *aricine*. [Cinchona, Alkaloids of.]

BLA'SPHEMY (in Greek βλασφημία, *blasphêmia*), a crime marked for public punishment in the laws of most civilised nations, and which has been regarded of such enormity in many nations as to be punished with death. The word is Greek; but it has found its way into the English and several other modern languages, owing, it is supposed, to the want of native terms to express with precision and brevity the idea of which it is the representative.

Among the canonists, the definition of blasphemy is made to include the denying of God, or the asserting of anything to be God which is not God,—anything, indeed, in the words of the 'Summa Angelica,' voce "Blasfemia," which implies "quandam derogationem excellentis bonitatis alicujus et præcipue divinæ;" and this extended application of the term has been received in most Christian countries, and punishments more or less severe have been denounced against the crime. Modern jurisprudence, according to Herzog ('Real Encyklopädie'), defines blasphemy as whatever by word or action designedly dishonours the religion of the state. It is made a penal offence, except in Bavaria.

In our own country, by the common law, open blasphemy was punishable by fine and imprisonment, or other infamous corporal punishment. The kind of blasphemy which was thus cognisable, is described by Blackstone to be "denying the being or providence of God, contumelious reproaches of our Saviour Christ, profane scoffing at the Holy Scripture, or exposing it to contempt and ridicule."

('Commentaries,' b. iv. c. iv.) All these heads, except the first, seem to spring immediately from the root-sense of the word blasphemy, as they are that hurtful and insulting speech which the word denotes. Blackstone ('Comm.,' b. iv. c. iii.), speaking of offences against the Established Church, says the punishments were "not for *thinking* differently from the National Church, but for *railing* at that Church and obstructing its ordinances;" and we suspect, that whenever the common law was called into operation to punish persons guilty of the first of these forms of blasphemy, it was only when the denial was accompanied with opprobrious words or gestures, which seem to be essential to complete the true crime of blasphemy. Errors in opinion, even on points which are of the very essence and being of religion, were referred in England in early times to the ecclesiastics, as falling under the denomination of heretical opinions [HERESY], to be dealt with by them as other heresies were. There is nothing in the statute book under the word blasphemy till we come to the reign of King William III. In that reign an Act was passed, the title of which is "An Act for the more effectual suppressing of blasphemy and profaneness." It stated that, "Whereas, many persons have of late years openly avowed and published many blasphemous and infamous opinions contrary to the doctrines and principles of the Christian religion, greatly tending to the dishonour of Almighty God, and may prove destructive to the peace and welfare of this kingdom; wherefore, for the more effectual suppressing of the said detestable crimes, be it enacted, that if any person or persons having been educated in, or at any time having made profession of, the Christian religion within this realm, shall, by writing, printing, teaching, or advised speaking, deny any one of the persons of the Holy Trinity to be God, or shall assert or maintain that there are more gods than one, or shall deny the Christian religion to be true, or the Holy Scriptures of the Old and New Testament to be of divine authority," &c. These are the whole of the offences comprised in this Act. The penalties are severe: disqualifications; incapacity to act as executor or guardian, or to receive legacies; three years' imprisonment. (Stat. 9 Will. III. c. 35.) As to its main provision, this Act remains in force; but in 1813, the number of persons who openly avowed that they did not consider the doctrine of the Trinity as possessed of sufficient support from the words of Scripture when truly interpreted, to deserve assent, having greatly increased, and large congregations of them being found in most of the principal towns,—several clergymen also of undoubted respectability, learning, and piety having seceded from the Church on the ground that this doctrine as professed in the Church was without sufficient authority,—a Bill was introduced into Parliament to relieve such persons from the operation of this statute, and it passed without opposition. This Act, which is commonly called Mr. Smith's Act, after the name of the late Mr. William Smith, then member for the city of Norwich, by whom it was introduced, is stat. 53 George III. c. 160. The last prosecution for blasphemy was that of Mr. Moxon, in 1841, for issuing an edition of Mr. Shelley's 'Queen Mab.' The prosecutor was a person who had himself been convicted of libel, and he retorted by putting this almost obsolete law in action against Mr. Moxon, who was convicted, but whose sentence was merely nominal.

BLAST FURNACE. [FURNACE; IRON MANUFACTURE.]

BLASTING. The article MINING describes briefly the usual mode of removing masses of rock, in such engineering operations as relate to excavations. This mode consists in the insertion of gunpowder into a small opening bored in the rock or stone, and firing this powder by means of a train and a slow-match, or by a safety-fuse. The present article relates to the much more effective employment of electricity, as an agent for igniting the gunpowder. The change is not in the explosive material employed, but in the mode of igniting the material, and in the vast scale which this modification enables the engineer to adopt. To those who have only a slight acquaintance with the nature of galvanism, this igniting power is a great mystery; but it may be readily explained thus: So long as a galvanic current can travel along a wire uninterruptedly, its progress is silent and harmless; but if the continuity of the wire be broken, or if anything occurs to interrupt the current for a small interval, intense heat and disruptive action take place at that spot, quite sufficient to ignite gunpowder if placed there. The arrangements therefore are such as to enable the wires of a galvanic battery to come nearly in contact at the place where the gunpowder is deposited for blasting.

Colonel (afterwards General) Pasley, after many useless attempts had been made to remove the sunken hull of the "Royal George" at Spithead, conceived that gunpowder might be carried down, by the aid of men descending in a diving-bell, and deposited in a water-tight vessel close to the ship, where it might be exploded by means of a galvanic current conducted by wires from an apparatus placed in another ship at some distance. The Admiralty having given the requisite permission in July, 1839, Colonel Pasley proceeded to form cylinders for containing the powder, and to provide electrical apparatus, boats of various kinds, a diving-bell, divers with water-tight dresses, and to make all the arrangements contingent on such a novel enterprise. The difficulties he met with were numerous, but he conquered them one by one; and at length, on September 23rd, he succeeded in exploding 2160 lbs. of powder, contained (under water) in a cylinder affixed to the outside of the hull of the sunken vessel. A second charge of 2300 lbs. was fired on October 15th. The effect of each explosion was

to shatter considerable portions of the ship, which portions were afterwards attached to chains and cables by divers who went down in diving-dresses, and then hauled up by men working at capstans above. The brass guns recovered by these means had a money value more than adequate to the whole cost of the operations; the wood recovered was chiefly placed in museums, or wrought up into articles of curiosity. Many different explosions, and a long series of auxiliary operations, were necessary to bring about this result.

The first application of the same agency to the blasting of rocks for engineering purposes was due to Captain Paris, an engineer at Boston, in the United States. Excavations were made in a rocky bed for the construction of quays and docks at that place; and the removal of the submarine rock was effected by galvanic blasting. The gunpowder was used in various quantities, from four to sixteen ounces, enclosed in air-tight tin canisters. The copper wires were inserted in the canisters; and these, as well as the powder, were secured by a waterproof composition. A hole was drilled in the rock for the reception of each canister, by a workman who descended in a diving-bell; and after securing the canister in the hole, and connecting all of them with a galvanic apparatus, a current exploded the gunpowder and blasted the rock. In the spring of 1842 the galvanic method was applied, under a modification introduced by Mr. Roberts, in blasting the rock of a quarry near the cathedral at Glasgow. In the same year some rocks were blasted under water, to aid in the reduction of a waterfall belonging to Lord Panmure, on the North Esk, with the view of rendering it accessible to salmon. In the autumn of the same year, the same agency was employed in making some excavations for the new harbour at Dunbar.

The experiment, however, which tested to the fullest extent the value of this system for engineering purposes was made by Mr. (afterwards Sir William) Cubitt, near Dover, in January 1843. The occasion for it thus arose: The six or seven miles intervening between Folkstone and Dover exhibit a continued series of bold cliff-works connected with the South-Eastern Railway; and it was on part of this course that the necessity occurred for a process of blasting on an unexampled scale of magnitude. Proceeding from Folkestone with these cliff-works, it was found that a bulky promontory, called the Round Down Cliff, stood directly in the way. It was first attempted to tunnel through this cliff; but the soil being unfavourable, the idea of removing the cliff at one blast by gunpowder occurred to Mr. Cubitt, the company's engineer. The arrangements for the explosion were thus made: A horizontal gallery was excavated through the cliff, extending for about one hundred yards parallel with the intended line of railway, in a direction nearly east and west. Cross-galleries were driven from the centre and extremes of this main gallery. At the end of each cross-gallery a shaft was sunk, having at its bottom an excavated chamber, eleven feet long, five feet high, and four and a half wide. In the eastern chamber was deposited about 5000 lbs. of gunpowder, in the western 6000 lbs., and in the central 7000 lbs., making about 18,000lbs. in all, or more than eight tons. The gunpowder was packed in bags; these bags were placed in boxes; loose powder was sprinkled over the open mouths of the bags; and the bursting charges were placed in the centre of the main charges. The distance of the charges from the face of the cliff varied from about fifty to seventy feet. These being the underground arrangements, those for firing the charge were as follow: On the surface of the ground, behind the cliff, was a wooden shed for containing three galvanic batteries; each battery consisting of eighteen of Professor Daniell's cylinders, and two common batteries of twenty plates each. The wires from these batteries communicated at the other end by means of a very fine wire of platinum, the red-heating of which by the passage of the electric current would suffice to ignite the powder. The wires, covered with yarn, were extended on the grass to the top of the cliff, and then falling over the edge, were carried to the three excavated chambers, and placed in connexion with the charges. The wires were each about a thousand feet in length. All the passages and entrances to the powder-chambers were 'tamped,' or stopped up with dry mud, rammed down hard.

At two o'clock in the afternoon of the 26th of January, all the preparations being ready, three engineers worked the three batteries simultaneously; the three wires conducted the electric current to the three chambers, and the mighty explosion took place. Many persons expected that noise, smoke, and fragments hurled to a vast distance, would accompany the explosion; but such did not occur. The rock seemed almost as if it had exchanged its solid for a fluid nature, for it glided downwards into the sea in one body. Sir John Herschel, who was one among many scientific men present, in a communication to the 'Athenæum' shortly afterwards, says, "Of the noise accompanying the immediate explosion, I can only describe it as a low murmur, lasting hardly more than half a second, and so faint, that had a companion at my elbow been speaking in an ordinary tone of voice, I doubt not it would have passed unheeded. Nor was the fall of the cliff (nearly 400 feet in height, and of which no less than 400,000 cubic yards were, within an interval of time hardly exceeding ten seconds, distributed over the beach on an area of 18 acres, covered to an average depth of 14 feet, and in many parts from 30 to 50) accompanied with any considerable noise, certainly with none that attracted my own attention, or that of several others similarly stationed, with whom I afterwards compared notes."

The complete success of this experiment (by which it is said six months' time and 7000*l.* were saved to the company) naturally led to the adoption of similar means in other like cases. On March 2, in the same year, a second blast took place, a little beyond Round Down Cliff, on a smaller scale than the former, as the mass requiring removal was not so bulky; there were 7000 lbs. of gunpowder used, and 50,000 cubic yards of chalk dislodged. On April 18 a third blast took place, which consumed 10,000 lbs. of gunpowder. Later in the same year, in October, a fourth blast took place, in which the powder was distributed in twenty-eight distinct parts, deposited in as many separate excavations, and all intended to be exploded simultaneously; but from some disarrangement of the wires, several of the charges did not explode, and these were fired separately on the following day.

The success of these really grand operations naturally drew the attention of engineers, both civil and military, to this powerful agent; and during the subsequent period of sixteen years, the employment of the method has been very extensive. Mr. Brunel employed electro-blasting in the cliff-works connected with the South Devon Railway; Mr. Bidwell, in quarrying rocks near the Wrekin Hill, in Shropshire, made use of the same agency; as did Messrs. Kemp in disintegrating a large mass of stone at Rosyth Castle. A small application of the same system occurred at Black Gang Cliff, in the Isle of Wight; and a very large one at Seaford, on the Sussex coast. The construction of Portland Harbour of Refuge (now rapidly advancing) is greatly facilitated by the occasional employment of electro-blasting. The same may be said in reference to the great harbour-works at Holyhead. Indeed, civil engineers now regularly employ this process in their great works of tunneling and excavating through hard rock; while military engineers are equally ready to avail themselves of it for destroying bridges or defence-works, and naval engineers for blowing up sunken or wrecked ships. The system has been partially adopted in clearing the harbour of Sebastopol of the ships which the Russians purposely sunk there in the autumn of 1854.

In the professional papers of the Royal Military Engineers much valuable information is given regarding the best modes of blasting rock. In one paper, containing 'Instructions for blasting Rock in the Works of the River Shannon,' very exact rules are given, of which a few may here be briefly noticed: The charges of powder are not to be regulated so much by the depth of the hole to be bored as by the length of the line of least resistance, or the thickness of the rock to be blasted. Charges of powder, to produce similar proportionate results, ought to be as the cubes of the lines of least resistance. In the larger class of explosions advantage may usually be taken of fissures in the rock, to economise the amount of powder employed. The quantity of powder required to fill a hole one foot in depth varies as follows, according to the diameter of the hole:—

1 inch	5·028 ounces
1½ „	11·304 „
2 inches	20·112 „
2½ „	31·416 „
3 „	45·240 „

One pound of powder loosely poured, but not shaken, will occupy about 30 cubic inches: a cubic foot weighs about 57½ lbs. When a rock about to be blasted is stratified, and in close beds or seams, the holes should be bored in the direction of the strata; when unstratified, a tolerably exposed and even face should be prepared, and the holes bored parallel to that face. In small explosions, more powder is commonly used than is necessary: the best mode has been employed when the report of the explosion is trifling, and the mass lifted and thoroughly fractured without any projection of the stones. For tamping, the best material, as well for efficiency as for safety, is dried clay; the clay may be rolled into cylindrical pieces of two or three inches diameter, or any other convenient form, and dried at a smith's forge. After the charge and the wadding have been introduced into the hole, an inch or two of the tamping should be simply pressed down, the ramming being used only for the subsequent portion of the tamping; by this means fewer accidents will occur than by ramming down the whole of the tamping.

It may not be amiss here to describe an ingenious raft or float employed by Mr. Casebourne a few years ago in submarine blasting, on the works of the Hartlepool West Harbour and Docks. This raft was contrived in consequence of the clay or marl which formed the bed of the channel into the harbour being so hard, at a certain depth, that the ordinary dredging-machine was found to have little or no effect on it. The engineer, to overcome this difficulty, contrived a new apparatus. It consisted of a platform or raft, supported by four legs, on each of which was fastened a rack working into a pinion on the deck or platform, so that the latter could be raised or lowered at pleasure. The working level on the ebb tide was about eight feet above the level of the ground, in which position it remained for about five hours, or five and a half, until the tide flowed again. During this time two sets of boring-irons were in use, working through wooden boxes or tubes. These tools made holes in the clay four inches in diameter, and of the necessary depth for receiving a cartridge containing three or four pounds of powder, to which one of Bickford's fuses was attached, and the hole was then carefully tamped: and when the tide rose to the level of the platform the fuses were lighted, the raft being floated away to some distance, to be out of danger when the explosion took place.

BLAZONRY, the art of delineating figures and devices in their proper colours or metals, on armorial shields: also used to express the hatching of the same, according to their different colours, by the engravers. The etymology of the word is somewhat uncertain, but Junius gives the English *to blaze abroad* as its origin, and he is probably right, for the Anglo-Saxon *blæs* has that meaning, and it has been used in that sense by modern English authors. Milton, in his paraphrase of Psalm cxxxvi., has—

> Let us blaze his name abroad,
> For of Gods he is the God.

The German *blasen* and the Anglo-Saxon *blæsan*, both meaning to blow or sound a horn or trumpet, may have contributed, as it was thus the attendants at a tournament announced the rank and dignities of the combatants. Mr. Lower, in his 'Curiosities of Heraldry,' says in a note that there are some who deduce it from the German *blasse*, a mark; a derivation we think wholly unfounded.

Allowing the mere invention to the Germans, says Dallaway, the splendid aid that heraldry receives from the art of blazonry is unquestionably the property of the French alone. Theirs are the arrangement and combination of tinctures and metals, the variety of figures effected by the geometrical positions of lines, the attitudes of animals, and the grotesque and almost inexplicable delineations of monsters. Dallaway, as well as other writers, considers that the tournaments held with such magnificence towards the end of the 10th century, under the auspices of Hugh Capet, were introductory of the more general usage and assumption of arms. (Compare Dallaway's *Inquiries into the Origin and Progress of the Science of Heraldry in England;* Gough's *Sepulchral Monuments of Great Britain;* Edmondson's *Heraldry,* pref.)

BLEACHING is the process by which certain animal and vegetable products, and especially such as are used as articles of clothing, are rendered white. The principal substances of the animal kingdom which are subjected to the operation of bleaching are wool and silk; those of vegetable origin are chiefly cotton and flax. These bodies contain a quantity of colouring matter, which though natural to them is not an essential constituent; it appears also that the colouring matter is more readily acted upon by chemical agents, and suffers decomposition with greater facility, than the animal and vegetable matters with which it is mixed. On these accounts it is removed by operations producing little or no injurious effect upon the texture or durability of the articles from which it is separated; and thus not only is their beauty increased, but they are fitted for the reception of the colours of the dyer and the ornamental designs of the calico-printer.

The process of bleaching is one of unquestionable antiquity, and more especially in Egypt, where white linen was used as clothing. Of the Egyptian processes nothing is known with certainty; they were probably tedious and imperfect; consisting perhaps of little more than exposure to air, light, and moisture. (See Plin. xix. 1, on flax.)

Down to the reign of George II. the art of bleaching was scarcely known in Great Britain; it being usual to send the brown linen manufactured in Scotland to Holland to be bleached. The Dutch method consisted in steeping the linen for several days in a solution of potash, which was poured upon it boiling hot; the cloth was then removed, washed, and afterwards put into wooden vessels containing butter-milk, for nearly a week. This operation being over, the cloth was spread upon grass, and exposed to light, air, and moisture for some months; the cloth sent from Scotland to Holland was generally kept there for half a year. One of the earliest improvements made in this tedious process was proposed by Dr. Home of Edinburgh, who introduced the use of water acidulated with sulphuric acid, instead of the sour milk previously employed: by this substitution a great saving, especially of time, was effected, for the sulphuric acid was as effectual in one day's application, as the sour milk in six or eight weeks.

Until the year 1787 little further alteration was made in the process of bleaching. But a most important improvement was effected in it in consequence of the discovery by Scheele, a celebrated Swedish chemist, of what he termed dephlogisticated marine acid, about the year 1774; this substance was afterwards called oxymuriatic acid, but is now known by the name of chlorine gas. The property which this gas and its solution in water possess of destroying vegetable colours, suggested to Berthollet the idea that it might be advantageously employed in bleaching, and might essentially shorten the process. In the year 1785 he read a paper before the Academy of Sciences at Paris, which was published in the 'Journal de Physique' of the same year. In this paper he mentioned that he had tried this gas in bleaching cloths, with a perfectly successful result: in the following year he published another paper on the subject, and showed the experiment to Mr. Watt, who first introduced this method of bleaching practically into England. About the same time Mr. Thomas Henry of Manchester was actively engaged on the same subject. Indeed, these gentlemen appear to have unreservedly described to each other the progress of their experiments: and to them belongs the chief merit of introducing the new mode into the neighbourhood of Glasgow, and into Lancashire. By the application of this method, as much bleaching is as well performed in a few hours, and in a space of a hundred yards square, as

on the old process would have occupied weeks of exposure upon a hundred acres of land.

Chlorine was first used in the state of simple solution in water; afterwards, in order to lessen its destructive action when used in too concentrated a state, it was proposed to add potash to it. This compound however was not found to answer the purpose; but in the year 1798, Mr. Tennant of Glasgow took out a patent for a liquid compound of chlorine and lime. This patent being set aside, he took out another for impregnating dry hydrate of lime with chlorine gas; this invention was not contested, and the chloride of lime, generally known by the name of bleaching-powder, is now almost universally employed, especially in the bleaching of cotton: it is a compound which answers the purpose with economy, celerity, and safety.

The colouring matter of cotton, flax, and hemp, is insoluble in water, and appears to be of a resinous nature: it is partially dissolved by heated solutions of lime and potash, or soda; and by their use, and the application of a solution of bleaching-powder and dilute sulphuric acid, the colouring matter which is not dissolved is destroyed. Cotton is more readily bleached than flax or hemp, and these more readily than wool: indeed this last-mentioned substance, as well as silk, is generally bleached by the fumes of burning sulphur, or sulphurous acid gas, after they have been properly cleansed. Straw and feathers are also bleached by sulphurous acid gas. Wax is generally deprived of its colour by mere exposure to air, light, and moisture.

The bleach-works of Lancashire and Glasgow are among the largest and finest of our manufacturing establishments; exhibiting mechanical contrivance, chemical knowledge, and those powers of combination and classification so remarkably developed where many hundred persons are employed in one establishment. The following is an outline of the series of processes, as conducted on a large scale: Supposing ordinary cotton-cloth or calico is about to be bleached, the 'pieces,' as they are called, usually of twenty-eight yards each, are sewn or tacked together into a web six or eight *miles* in length; which web, connected at the two ends, becomes practically endless, like the travelling-web of a printing machine, or the wire-web of a paper-making machine. This web is passed over a heated cylinder, to singe off the loose fibres; it is then washed to remove the flax or dressing; it is next exposed for eight or ten hours to a hot solution of lime; and is again washed to remove the lime which may adhere to the fibres. The long web of cloth is then steeped in water containing a little sulphuric acid; after which it is washed a third time in clear water. Three of these long webs, making twenty-four miles in length of calico, are boiled in a solution of soda, then washed, then passed through a weak solution of bleaching-powder, and then allowed to remain in a heap for the chloride to act on the fibres. Next come, in succession, a second dip into dilute acid, a fifth washing, a second application of soda, a sixth washing, a second application of bleaching-solution, a third dip in the acid, and a seventh washing—thus showing, in a striking degree, how complex are the processes which modern ingenuity enables the manufacturers to carry on at a very cheap rate. The bleached calico is washed in hot water, and squeezed between rollers; the web is separated into its component pieces; and each piece is folded and dried. It may be remarked that the bleaching of other kinds of cotton goods, and of yarn and thread, although involving minor peculiarities, may be understood from this description of the bleaching of calico and of cotton for printed dresses.

Not a year elapses without developing some new processes or apparatus for bleaching; many of these novelties are made the subjects of patents, though not always with advantage to the patentees. One patent, by M. David, of Paris, relates to a peculiar mode of applying chlorine to the goods to be bleached. The chemical materials for making the gas are to be provided by the bleacher; and as the gas is generated, it is conveyed by pipes into a close chamber. The woven goods are to be laid on perforated shelves in this chamber, and thus be acted upon by the chlorine. A fan or blowing-machine is used to clear the chamber of gas before the goods are removed from it; and glass windows are provided to the chamber, through which the process may be watched. A second patent relates to a peculiar way of conducting the cloth into and through a vessel of liquid, and beating it on both surfaces immediately after its immersion, in order that the fibres may become impregnated and the superfluous liquid be driven off. Another patent is for a peculiar mode of causing the woven goods to pass over two rollers, one above the other, in a close chamber filled with chlorine or sulphurous acid gas. Passing over many inventions of varied character, we may advert to a dash-wheel invented by Mr. Wallace of Glasgow, and brought largely into use in 1857. The dash-wheel, generally used by bleachers, dyers, and calico-printers, is a hollow cylinder or box, made to rotate with great rapidity, so as to wash very speedily any woven goods immersed in water within it. Now Mr. Wallace's plan is to render the dash-wheel more extensively available than heretofore as a bleaching and cleansing apparatus. The wheel is mounted on a hollow shaft, by which it is put in communication with a steam-pipe. Steam, instead of water, is admitted through perforations in the shaft, into the several compartments into which the interior of the wheel is subdivided. Acids, alkalies, or soaps may be placed in cisterns above the wheel, in solution with water; and may be made to descend through pipes into the hollow shaft. By this means, any admixture or variety of chemical agents, whether for washing or for bleaching, may

be admitted into the wheel, and made to act upon the woven cotton goods placed in the several compartments. The liquid, when the washing or bleaching is effected, finds egress by holes in the circumference of the wheel. A dash-wheel of six feet diameter, on this construction, is estimated to make twenty-four revolutions per minute; one of nine feet diameter, sixteen revolutions—the velocity of the circumference being in each case about four hundred and thirty feet per minute. A steam-engine of about five-horse power, with steam of three or four pounds per inch above atmospheric pressure, would produce this degree of revolving action.

With respect to the theory of bleaching it may be observed, that the action of lime and the alkalies, potash and soda, appears to be that of mere solvents; they probably dissolve the colouring matter without effecting much alteration in its properties. The actions of atmospheric air and chlorine seem to be similar to each other, and very different from that of lime and the alkalies. The oxygen of the air aided by the action of light and moisture apparently combines with and destroys the colouring matter; while the chlorine, decomposing the water which is present, forms muriatic acid with the hydrogen of the water; another portion with its oxygen probably giving rise to a compound of easy decomposition, the nascent oxygen of which acting like that of the air, though more powerfully, produces the same oxidising effect upon the colouring matter, but more perfectly, and in a much shorter period. That water is necessary to the action of chlorine upon vegetable colouring matter, is shown by immersing dry colouring matter in the dry gas, in which case no decoloration whatever is effected, but it ensues immediately on the introduction of water. The bleaching of rags for paper-making is effected by the agency of chlorine. Paper also, when written on or printed, may be bleached by the same means. There are some operations in which the removal of colour is hardly referable to the process of bleaching; such for example as the decoloration of sugar, which derives its colour, not from any natural cause, but the partial decomposition effected by heat. This is removed by what is usually termed animal-charcoal or ivory-black; which powerful decolorant is also used in some chemical operations for the same purpose.

We must now notice the proceedings connected with bleach-works regarded as *factories*, subject to legislative control.

An opinion has during several years prevailed among many persons conversant with the manufacturing establishments of the North, that when spinning and weaving mills were placed under the operation of the Factory Act, in relation to the employment of women and children, bleach-works ought to have been included, as well as print-works and dye-works. The manufacturers, on the other hand, have all along contended that there was no need for such an extension. The attention of Parliament having often been called to this subject by the upholders of the Factory Act, at length, in 1854, the Government appointed a commission—"To inquire how far it may be desirable to extend the provisions of the Acts for the better regulation of Mills and Factories to bleaching works;" and Mr. Seymour Tremenheere, one of the factory inspectors, was appointed commissioner. The commissioner presented his report in June 1855. It is necessary to mention that this inquiry arose out of a movement which was marked by much collision of opinion. Early in 1854 the Earl of Shaftesbury brought into the House of Lords an "Operative Bleachers Short Time Bill," intended to restrict the labour of females and young persons in bleach- and dye-works to ten hours and a half per day. He was supported in this by the operatives themselves. There was also a petition sent to Parliament signed exclusively by members of the clerical and medical professions, 128 in number, all resident in or near Manchester. The petition declared that females and young persons often worked from fourteen to twenty hours a day in bleach- and dye-works, and sometimes for days and nights consecutively without intermission, except for meals; and they insisted that nothing but legislative interference could remedy the evil. The master bleachers contested these statements, in a memorial addressed to Lord Palmerston. They did not, it is true, deny that the hours of work were sometimes very long; but they asserted that this was a necessary condition of certain peculiarities in the trade. "The trade of bleaching and finishing is difficult to manage; and it differs from other branches of the cotton trade in this—that the supply of goods to be bleached fluctuates. During some portions of the year we are only partially employed, whilst at other times we have more work to do than could be accomplished if the hours of labour were restricted." They declared that the greatest care, industry, and skill are required to enable English bleachers and dyers to compete with those of the continent and of America; and that any legislative enactment which increased the working expenses would be disastrous to the bleachers, who had no less than two millions sterling of capital sunk in the trade. The Earl of Shaftesbury's Bill, though passed by the Lords, was checked in its progress through the Commons by the lateness of the session; but the discussions in both Houses led to the appointment of the commission above adverted to.

Mr. Tremenheere, after visiting most of the principal bleach works in the United Kingdom, classified the processes into three groups—preparing, bleaching, and finishing. The preparing includes the marking with the needle the pieces of cloth with the initials or private mark of the owner; sewing or pasting the ends of several pieces together, to facilitate the subsequent processes; and dressing or

singeing the cloth by means of hot plates or jets of gas. The bleaching comprises all the processes of a chemical nature. The finishing includes mangling, drying, calendering, hooking, folding, making-up, labelling, and packing. Where the dyeing is effected by the bleacher (which is often the case) it is included among the processes of "finishing." At a large bleaching establishment near Bolton, Mr. Tremenheere found the designations of work people to be more than twenty in number: the loaders, banders, dressers, bowkers, crofters, wheelers, tubbers, baggers, white-washers, squeezers, white-manglers, dyed-manglers, rawers, stovers, pelters, calenderers, makers-up, calico-packers, shirting-packers, beetlers, chest-manglers, canroyers, dyers, black-dyers, stitchers. Mr. Tremenheere appears to have been unable to ascertain the total number of hands engaged in this trade. The largest firms mentioned by him are Messrs. Ainsworth's, Messrs. Ridgway's, and Messrs. Hardcastle's, all in the Bolton and Bury district, and employing respectively 508, 461, and 440 hands at the time of the inquiry. Concerning the long hours of work, there was no doubt, Mr. Tremenheere said—"Some masters will have so much employment as to keep their hands employed for twelve months together from between six and seven in the morning until eight, nine, or ten at night; and a portion of their hands will occasionally work on to a later time, and sometimes nearly all night, for two or three nights together. The evidence shows that both at the large and small bleaching and finishing works a very common state of things is that the work goes on for these 'long hours' (as they are called) continuously for months together; in some instances, for so many as six months, in others for twelve months or more." On a review of all the observations made and evidence taken, Mr. Tremenheere arrived at an opinion that the hours of labour for women and young persons in bleach works ought to be limited by legislative enactment—admitting, at the same time, that the working expenses would be increased thereby.

Towards the close of 1855, another bill was brought into the House of Commons, to carry out the commissioner's recommendations; but this, partly owing to the advanced state of the session, and partly to the opposition raised, was thrown out on the second reading. In 1856 a further attempt was made, but was defeated by a still larger majority than in the preceding year. In 1857, owing to doubts expressed concerning the correctness of Mr. Tremenheere's statements and deductions, the House of Commons appointed a committee "To inquire into the circumstances connected with the employment of women and children in the bleaching and dyeing establishments in England, Scotland, and Ireland; and to consider how far it may be necessary or expedient to extend to those establishments provisions regulating such employments." The committee presented one report on the 5th of July, and another on the 28th—simply announcing that the inquiry was not completed, and recommending the re-appointment of the committee in the next session, 1858. The master bleachers examined by the committee declared, as with one voice, that the hours of working cannot be made regular; the orders come to them irregularly, and must be attended to whenever and as soon as they come. The nature of the market is such as to give generally two very long seasons in the year to the bleachers, in spring and autumn, with intervening periods of greater leisure; and the bleachers assigned reasons why it is better to vary the hours of work than the number of hands. During the session of 1858, the attention of parliament was too much absorbed by other subjects to attend to the one in question; and down to the present time (May 1859) bleach works remain free from the operations of the Factory Act, or of any statute limiting the employment of women and children.

For certain particulars further illustrating the subject of the present article, see BANDANAS; CALENDERING; CALICO-PRINTING; DYEING; FACTORIES, and FACTORY ACTS.

BLEEDING, the operation by which blood is removed from the body, with a view to the prevention and cure of disease. Bleeding is either general or local. General bleeding is practised when the object is to lessen the whole mass of the circulating blood; local, when the object is to lessen the quantity in some particular part of the body. General bleeding consists either in opening a vein (venesection), or in opening an artery (arteriotomy). Venesection, the most common mode of abstracting blood, is a simple operation, and in skilful hands neat, elegant, and safe; but in unskilful hands dirty, bungling, and exceedingly unsafe: it is always performed with a lancet. Various means are employed for the removal of blood from particular parts of the body, such as cupping-glasses, the scarificator, the division of visibly distended vessels with a lancet, and leeches. The mode of performing the operation of venesection and arteriotomy is fully detailed in the common books on surgery, where the requisite precautions are pointed out. It is only necessary to add here, in reference to local bleeding, and more especially to the application of leeches, that when there is a difficulty in making leeches fix readily on any particular part, they may often be made to do so at once, by first cooling the part with a cloth dipped in cold water, or by moistening it with cream or milk, or a single drop of porter, and then confining the leeches in the proper situation under a small glass. It should be borne in mind that these animals are cold-blooded, that heat is highly injurious to them, and that handling them with the warm hand, or keeping them long out of water in a heated room, totally unfits them for the performance of their office. Great fatigue to the patient, great aggravation of his disease, and even the loss of life itself, sometimes result from the ignorant and unskilful manner in which attempts are made to apply leeches. In the diseases of infants and children especially, in which general bleeding can rarely be employed, the preservation of life constantly depends on the efficient application of leeches.

It is scarcely one time in a hundred that the physician finds a single person in a family who has the slightest notion of the proper mode of performing this service to the sick. It would be wonderful indeed were it otherwise, when the education of women, in reference to the entire class of subjects the knowledge of which is necessary to qualify them for the performance of their duties as nurses and as mothers, is universally and wholly neglected.

The conditions of the system which require the abstraction of blood, and the benefit which the removal of it is capable of effecting, will be better understood after reading the account of the blood. [BLOOD, NAT. HIST. DIV.]

BLENDE. (ZnS.) The natural sulphide of zinc, constituting an important ore of that metal. [ZINC, SULPHIDE OF.]

BLIGHT, a popular name for any kind of pestilence which affects cultivated plants by curling up or destroying their leaves and blossoms, or by giving them a yellow sickly appearance, or by covering certain parts of them with unnatural colours. Dr. Lindley thus describes the popular idea which the word under various circumstances is used to express. "Blight is a sunstroke or frostbite, a plague of insects or of fungi, a paralysis of the roots, a gust of bad air; it is wetness, it is dryness, it is heat, it is cold, it is plethora, it is starvation, in short it is anything that disfigures or destroys the foliage." To a term thus loosely applied no precise meaning can be assigned; for the effects to which it relates are produced by causes of totally different kinds. The attacks of insects, especially of the aphis, produce a curling in leaves, and a stoppage of growth; caterpillars spread their nets from branch to branch, destroying all they meet with; cold dry winds in the spring, or sharp night frosts at the same period, cause an appearance of scorching; and finally the ravages of numerous parasitical fungi, some of which are superficial and others intestinal, are the origin of much that is popularly called blight. The attacks of insects form a subject which it is the business of the entomologist to explain. Blight from the attacks of parasitical fungi will be explained under the head of MILDEW; that which is produced by meteorological influences may find a brief notice in this place.

Nothing can be more absurd than the explanations of this malady as given by many writers on gardening, nor anything more simple than it is in reality. One person talks gravely of its being caused by certain transparent flying vapours, which may sometimes take such a form as to converge the sun's rays like a burning-glass. The fact appears to be this: when a plant first produces its young branches and leaves, all the new-born parts are tender and succulent, and part with their fluid matter with rapidity until the solidification of the recently-created tissue has taken place. To enable this function to be performed regularly and without interruption, it is necessary, 1. that the air should be in a certain state of humidity, or the perspiring parts will lose their aqueous particles too fast; and, 2. that the temperature should not be low enough to destroy the vitality of the tissue. Suppose these conditions to be maintained without interruption, leaves and branches gradually become fully formed, and no blight appears; but if, as frequently happens in this country, the air is rendered extremely dry by the prevalence of easterly winds, the young parts perspire with such rapidity that the loss thus occasioned cannot be made good by the roots, and the consequence is that the tissue becomes dried up and scorched as it were, or at all events is brought into a more or less diseased condition. Such is blight properly so called, if that term can be considered applicable to any particular form of disease. It will be obvious that the only remedy for this, after it has occurred, will be the restoration of the atmosphere to the necessary state of humidity, or to a sufficiently equable temperature. For this, artificial means can only be employed upon a limited scale, and perhaps the only practice which is ever attended with much advantage is frequently washing the blighted plants with a syringe. It has by some been recommended that wet litter should be burned to the windward of large tracts covered with blighted plants, and it has been supposed that the smoke thus produced will remedy it by destroying insects, its imaginary cause; but if any effect is ever obtained from such a practice, it is not by the destruction of insects, but by the interposition of a canopy of smoke at night between the plants and the sky, by which radiation is stopped, and the severity of the cold diminished.

Blight is often used to designate the mischief done by those insects which are destructive to vegetation; and consequently many insects of various genera and even orders must be included under this common denomination; but it is not our intention, however, to describe the habits of all these various species, as they will be found under their respective heads in NAT. HIST. DIV.

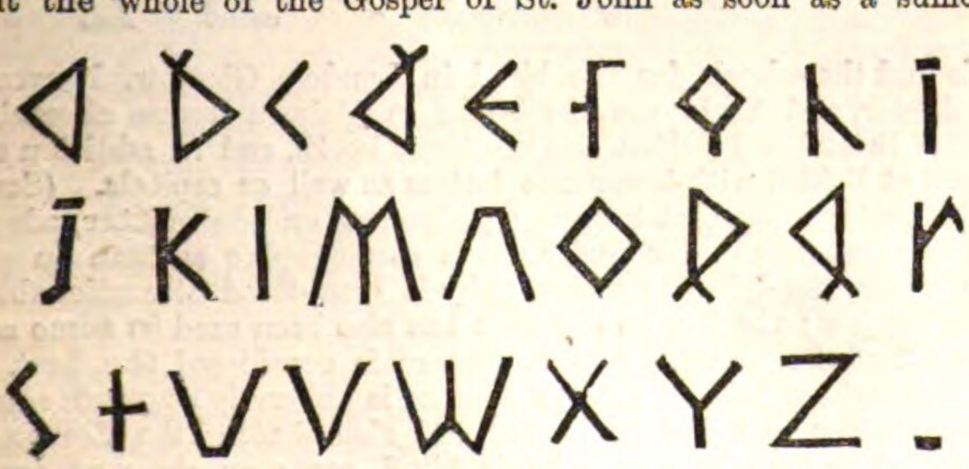
The aphides, or plant lice, especially, are great pests to the gardener. [APHIS, NAT. HIST. DIV.] It may be observed, however, that as each infested plant has its peculiar aphis, and as the aphides are quite as numerous (if not more so) when the plants are covered with a glass as when they are exposed, it is absurd to imagine that blight is bred in the air (the vulgar notion), and brought to these plants by the wind. Certain winds may be more favourable than others for hatching the

young, which however are undoubtedly deposited on the plants by the parent insect.

BLIND, ALPHABETS FOR THE. The early instructors of the blind felt the irksomeness of oral instruction, and the dependent condition of their pupils. Without being aware what results might follow they early made the first step towards tangible printing, by the invention of letters in relief, by which the alphabet might be taught—letters put together to form words, and these arranged in sentences. In the first attempt thus made, the letters chosen were those of the Illyrian or Sclavonian alphabet modified. [ALPHABET]. This alphabet was doubtless preferred on account of the square form of the letters, which it was thought would make them more obvious to the touch than ours. ('Essai sur l'Instruction des Aveugles,' &c., par le Docteur Guillié, p. 134, 2nde edition.) The principle of square or angular letters was afterwards abandoned, as "not offering greater advantages than common characters." Moveable letters were next invented, which were placed on small tablets of wood, and were made to slide in grooves, on a similar plan to some of the toys which are used for the purpose of inducing children to learn their letters, spelling, &c. It was with similar letters that Usher, archbishop of Armagh, was taught by his two aunts who were both blind; but this process was found defective for teaching blind persons. Moveable leaden characters were afterwards cast for the use of the blind, by Pierre Moreau, a notary of Paris; but the work was attended with difficulties and expenses which he was not prepared to encounter. Large pin-cushions were also brought into use for the blind, on which the characters were figured with 'inverted needles.' The relief caused by the heads of pins would have been more eligible. Various other attempts were made in wood and metal till the time of Haüy, who invented the art of printing in relief for the blind, and thus devised a plan by which the blind man might acquire knowledge, and derive amusement during his solitary hours independent of a teacher or an attendant. The invention of printing in relief is said to have arisen from the sight and feeling of a proof of common printing fresh from the press.

Previous to the time of M. Haüy no success had been obtained in the art of printing for the blind, though it had been attempted in a variety of ways, and by different persons. Letters were engraved in wood, not cut in relief, but in the ordinary manner of wood-cutting. The configurations of the letters were found to be difficult to trace, possessing none of the advantages which letters in relief afford. Haüy's was a bolder invention than any other offered to the public. Not only has it never been superseded, but from it have arisen all the modern efforts to teach the blind reading by means of relief characters.

Various attempts were made in our own country to produce tangible alphabets, and embossed books for the blind. An impetus was given to them in 1832, in consequence of the Society of Arts in Scotland offering their gold medal, value twenty sovereigns, for the best alphabet and method of printing for the use of the blind. Twenty-one alphabets were submitted to the committee appointed on this occasion, fourteen for competition and seven for non-competition. Of all these, *four* only, with or without modification, have survived, while two additional systems have come into use. All these will be presently examined. The character which the French schools had adopted was an upright script, widened, as was falsely thought, to render it more obvious to the touch. Two alphabets were also employed, one of capitals and another of small letters. To these two errors in the outset may be attributed the failure of the attempts in France to make the blind readers, and to furnish them with books. The wide and complicated forms of script letters detained the finger in tracing their shape. The acquisition of fifty-two letters instead of a single alphabet doubled the amount of time required to become familiar with them, to say nothing of the complicated mental operations to be at the same time carried on by the readers. For two or three years previous to the wise and liberal offer of the Edinburgh Society of Arts, James Gall of Edinburgh was the sole labourer in the cause of printing for the blind. He adopted a modification of the Roman alphabet, in which he excluded curves and circles, and substituted straight lines and angles. He also abolished the capital letters, and thus reduced the number of characters to be acquired to twenty-six. He succeeded in producing beautiful and enduring workmanship on good paper. He printed several preparatory books which the blind read with ease; and he offered to print the whole of the Gospel of St. John as soon as a sufficient

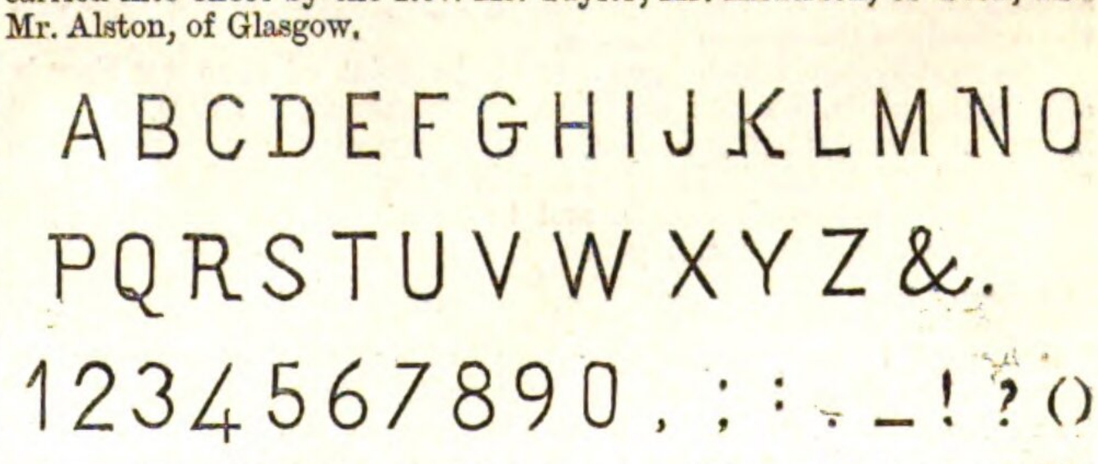


number of subscribers should be obtained, at a guinea a copy. The immense cost of a single gospel acted as a great discouragement to his plans, and before he could remedy it other labourers were in the field,

and his market was in the possession of other producers. Great merit is however due to Gall, and he must be looked upon as the forerunner of that success which has followed the labours of others. He had removed some difficulties. The works of the French were bulky and expensive; by Gall's angular alphabet much economy in space was gained, and experience proved that it possessed merits of tangibility not to be found in the French alphabets.

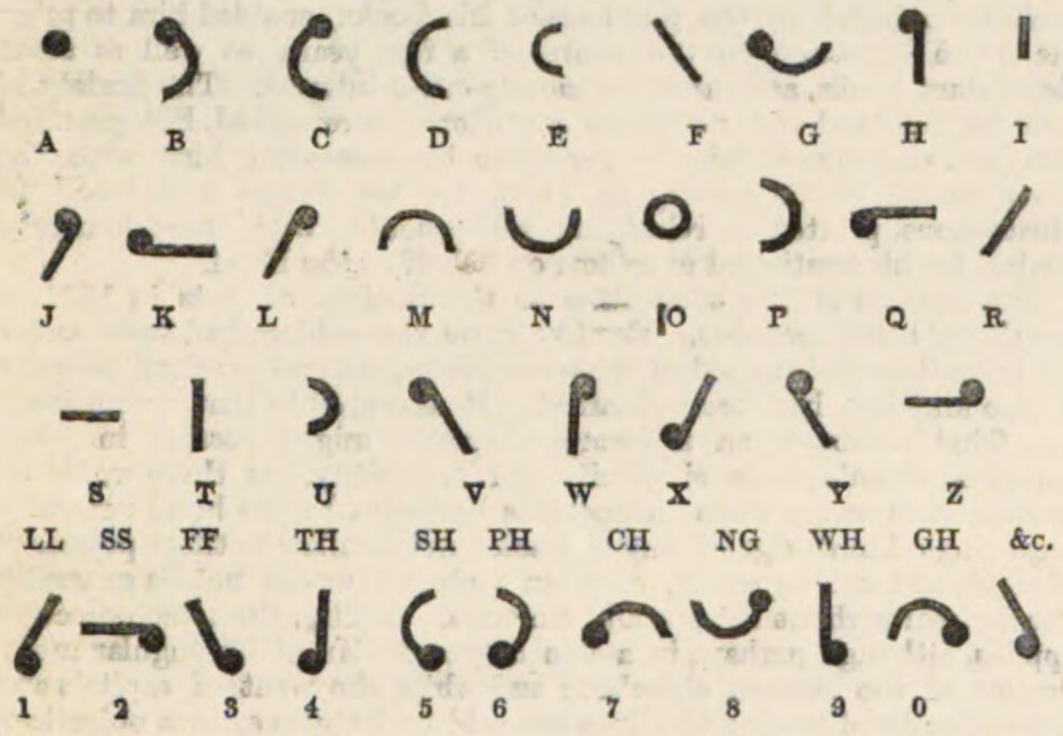
The character which found the greatest favour with the committee appointed to award the gold medal of the society, was the Roman letter of Dr. Fry, to which the prize was finally awarded. But the committee, before deciding, called in the aid of several experienced men to assist them in coming to a right judgment; among others, the Rev. W. Taylor, a gentleman who had been practically engaged in inventions for, and in the instruction of the blind for many years. He was an honorary member of their society, and at the time when his opinion was sought, he was at the head of the recently established School for the Blind at York. Better aid the society could not have procured. To him all the alphabets and communications were submitted, and upon them he made a very copious and able report. Mr. Taylor sets out with saying there does not appear to him "*sufficient* reason for departing from the *common Roman letter*." He then mentions a few modifications which he would introduce in Dr. Fry's sans-serif Roman capital, and speaks decidedly against any merely arbitrary character. It is unnecessary to go into Mr. Taylor's report in all its details. The practical part of the subject was taken up by the late Mr. Alston, then the Treasurer of the Asylum for the Blind in Glasgow; he found the letters of Dr. Fry too broad in the relief, and increased their tangibility by having them made sharper; some other slight alterations were also introduced by his skill and experience. The encouraging approval of his efforts by many of the schools for the blind, together with the pecuniary aid they and the various Bible Societies afforded by the purchase of his books, enabled him to print the entire Scriptures in the course of a few years, as well as some elementary books, and others of more general interest. The Society of Arts for Scotland did not leave his efforts unrewarded, but gratified him and encouraged him to persevere by presenting him with the silver medal of the society in 1838, for his Fables with wood-cut illustrations, printed in relief, and subsequently with three honorary medals for his continued exertions on behalf of the blind.

The decision of the committee of the Society of Arts in 1837, is worthy of being recorded. For five years the subject had been under consideration, and the aid of the most intelligent and practical teachers in the kingdom had been obtained. It appeared to that committee: "1. That although an arbitrary character might possess in itself superior advantages in simplicity and tangibility, yet there would be great, and in many cases insuperable obstacles to the blind generally acquiring a knowledge of any character not familiar to those possessed of sight, and consequently, such an alphabet would not be generally adopted throughout Europe and America. 2. That the same objection applies, although perhaps in a less degree, to Mr. Gall's angular modification of the Roman alphabet; and while the want of capitals and the difficulty of tracing the lines are said to be also serious objections to the use of his character, it does not in other respects seem to offer sufficient reasons for its adoption in preference to the Roman alphabet slightly modified. 3. That, from being almost universally known both in Europe and America, and taking all other circumstances into consideration, the common Roman capital alphabet, as represented by the late Dr. Fry, * * * seems not only the best adapted for teaching the blind to read, but also as a medium of written correspondence. Hence, there is every reason to believe, that it would be sooner brought into general use than any of the other characters in competition—that books printed with it would be more in demand—and, consequently, that their expense would be greatly diminished." The committee guard themselves against the one or two inherent defects in Dr. Fry's alphabet by further stating, that in proposing his communication as best entitled to the society's premium, they "do not wish it to be understood that they consider his modification of the Roman alphabet as *now* in every respect the best adapted for teaching the blind, but only that it was superior to any of the others given in to the society for competition, and remitted to the committee for consideration," and they then allude to the improvements on it since proposed and partly carried into effect by the Rev. Mr. Taylor, Mr. Anderson, of York, and Mr. Alston, of Glasgow.



One of the alphabets submitted for competition, was of stenographic characters, the invention of Mr. T. M. Lucas, of Bristol. As this alphabet has many adherents it claims respectful notice, premising that

it was in use some years before the Society of Arts arrived at its decision, and that its claims were very ably advocated by the late Rev. Dr. Carpenter, LL.D., of Bristol, whose letter addressed to the society, contains many valuable suggestions on printing for the blind. Mr. Lucas has himself stated that the 'Penny Cyclopædia' contained a fair exposition of his principles, which we are glad to reproduce:—"The characters are employed for reading, writing, arithmetic, and music; and they are so simple, that to any book for the blind, not more than half the number of types are required that are necessary to print the same for those who are blessed with sight. Should the event prove as successful as is intimated in the above announcement, and so great a barrier to the improvement of the blind be removed, it will be desirable that the different institutions should unite their exertions, and set apart a common fund to supply their pupils, as well as other blind persons. with so powerful an auxiliary to their progress in knowledge. The alphabet is composed of thirteen simple characters, and thirteen formed from the roots of these with a crotchet-head to each. There are ten double letters from the same roots, distinguished also by the crochet-head: these also represent the nine figures and the cypher, whether used as numerals or ordinals. In all thirty-six characters are employed. The advantages attending the use of stenographic characters seem to be in the saving of types, paper, and labour, thus materially diminishing the cost of books for the blind. The disadvantages attending the system we are speaking of appear to consist chiefly in the confusion which the learner must feel in having but one character employed in several offices, as in the double letters, numerals, and ordinals, and in the necessity that every person should be a stenographist who communicates with the blind by writing. These difficulties are not very great for persons to overcome who have never been accustomed to a written language.



"The manner in which the characters of Mr. Lucas are employed may be seen in the following commencement of St. John's Gospel, only that we give the extract in Roman letters instead of using the stenographic characters.

t gospl b st jon, chap: 1.

in t bgini ws t wrd a t w ws w g, a t w ws g. t sam ws n t bgini w g. l thins wr mad b hm, a wo hm ws nt athin mad tht ws mad. in hm ws lif a t l ws t lit f mn.

"It will be observed that the repetition of numerous letters is avoided; particles are represented in most instances by their initial letter, and when a word, having been once mentioned, recurs immediately, or frequently, it is represented by its initial letter also."

An undoubted defect in Lucas's system is the confusion which must arise from having double letters and figures, whether cardinal or ordinal, represented by the same stenographic signs; thus the signs for th, ch, and ll also represent 471. The contractions are very numerous, many words are expressed by a single character, and other words are contracted by the omission both of vowels and consonants. The value of full spelling is great, especially to the young blind; those who have already learned to read while possessing sight, would, in time, get over the difficulties the system presents.

The next system which came into use in point of time was Frere's, also stenographic, founded on Gurney's shorthand, as Lucas's was on Byrom's. This system is phonetic, and is formed on the "combination of elementary sounds." It professes to be composed of twenty-nine signs, to be extremely simple, and to have only four descriptions of signs, which represent thirty-two different sounds. Its distinctive principle, compared with Lucas's, is the phonetic one, the powers or vocal sounds of the letters rather than their name-sounds being taught, "each word being embossed according to its actual pronunciation, the names of the characters combined, or sounded together, give the word." The 'Memoria Technica' which accompanies the lessons is most burdensome, and the twelve rules in verse for supplying the omitted vowels could never be regarded by blind or other readers who had to commit them to memory, in any light but as a distasteful task. We learn, however, that their employment is *optional*, though the

system would be incomplete without them! The twelfth of these rules is:—

"Whene'er the proper rule don't yield you satisfaction,
On trial you will find the word is a contraction."

"A fair knowledge of the system may be acquired *by those who have sight* in three or four hours." Two things are noteworthy in this agreeable announcement. 1. That a system of stenographic reading can be acquired in three or four hours. 2. That stenographic systems require ordinary readers to learn them before they can assist their blind brethren in the acquisition of the art of reading.

The last system to be described is Moon's; although it is not stenographic in one sense, its characters have sufficiently the appearance of stenography to be taken as such; and again, although it claims to be the common alphabet simplified, it is certainly arbitrary enough for a first observer to recognise no similarity between it and the forms to which he has been accustomed. Mr. Moon, like Mr. Frere, is himself a blind man, and he has laboured hard to establish a system which he believes is destined to supersede all others. If all that he says in its favour could be taken for granted, no further question could arise as to the best alphabet for the blind. The judgment and experience of those who have means and opportunities for deciding, at least equal to Mr. Moon's, but whose zeal, enthusiasm, and interest are not fettered by partial views, do not bear out his statements.

"Moon's system is adapted to the cottage, *because anybody can teach it.*" This statement is more than questionable. Anybody of moderate intelligence can doubtless acquire it if they can already read. The same may be said of Alston's books, and herein consists their superiority—anyone who can read may at once be a teacher of reading to the blind. "It is adapted to the dull finger of the labourer, because it is *very plain to the touch.*" This is no exclusive advantage in Moon's letters. "It is suited to the aged, the sick, and the ignorant, because it is so *easy to be understood.*" This is a benefit compared with Lucas's and Frere's, but in this respect Alston's is certainly more deserving of praise. "The words are spelt at full length," and "full spelling is essential to accuracy." Granted, so are Alston's, which system does not employ even the few contractions Moon introduces; in this respect Moon's books are superior to Frere's or Lucas's, but inferior to Alston's. Moon's alphabet consists of "the *common letters simplified*, and therefore is easily learnt and taught by all who know their a b c." But, Alston's consists of the common letters themselves. We have doubts about the easy recognition of the transformed letters, though none as to the increased tactile power of the new forms in comparison with the certainly more intricate forms of the ordinary alphabet. "Six of the Roman letters are retained *unaltered;* twelve others have parts left out so as to be left open to the touch, and yet be easily remembered as half of a well-known letter." Of these twelve none would be recognised from any similarity they bear to the letter they represent; they must therefore be regarded as arbitrary characters. "Five or six new and very simple forms complete the alphabet." These are arbitrary; so that this system of the "common letters simplified" is in fact composed of six of the Roman letters unaltered and eighteen arbitrary characters. Most certainly Moon's alphabet does not possess the superiorities over others to which it lays claim. That it is a *good* arbitrary character for the blind no one who has paid the least attention to the subject can deny. The question, however, has yet to be settled whether an arbitrary or an alphabetical character is the best for the blind. And on this point evidence must be adduced.

We find the schools for the blind in London, Glasgow, Newcastle, Manchester, and York, use the books in Alston's Roman characters; those of Bristol and Belfast also use these books, and in addition some printed at Bristol with lower-case letters as well as capitals. (Several of the parties competent to form a judgment on the matter, advocate the use of capitals.) We find Lucas's stenographic system in use at Bath, where the defective orthography is considered objectionable for young readers; the Roman alphabet has also been used in some cases; while for adults generally Moon's system is considered the best. At the Nottingham school, Lucas's system is generally adopted, some of the pupils also read Moon's books, and also those in the Roman characters. The schoolmaster, who is blind, reads on six systems, but gives a decided preference to Lucas's. The pupils read quite as rapidly as is necessary, and as correctly as others of the same age with sight. The superintendent of this school says "Lucas's books are

less bulky than those in the Roman type and consequently cheaper." The statement received from Birmingham is similar to the above, "All the pupils read on Lucas's system, it is much liked by them, and preferred to any other; the value of a full orthography is understood, but the bulk and expense are considered objectionable. The Roman type is not generally considered readable." (Whether Alston's or the American Roman type is here referred to is not stated.) The Exeter school furnishes the following information. "Lucas's books are used here, and with but one or two exceptions, all have been able to read the scriptures. Our pupils have tried several systems. All of which they could learn, but they find Lucas's the easier to read." "The London Society for teaching the blind to read," situated in Avenue Road, Regent's Park, has become the head-quarters of Lucas's system. This society has published the whole of the Bible, which is sold in separate books or portions, the Liturgy, and several elementary works. The system has been revised and improved under the superintendence of the Rev. J. W. Gowring. Mr. Moon's printing establishment is at Brighton, but it has agencies at work in London, Birmingham, Edinburgh, and many other places for the introduction of the books. Moon's system has been well-received by the blind and extensively adopted; it is used in the schools of Brighton and Edinburgh. The testimony of Thomas Campbell in the name of the inmates of the asylum in the latter-mentioned city, speaks of Moon's books as superior to all others; his letter traces the efforts made in that asylum with respect to Gall's, Alston's, the American, and Lucas's systems, and his conclusions are entitled to consideration, for they are the results of experience strongly supported by facts which are adduced. He emphatically states "that Mr. Moon's system is not only the best ever devised, but that it is the only one capable of imparting lasting benefits to the working blind." In the various publications advocating the use of this system great stress is laid on its adaptability for the aged, the nervous, and the working blind—those generally in whom the sense of feeling is less than ordinarily acute. It is clear that as a system it can afford to stand on its own merits, and that its adherents need not depreciate other plans while they support its peculiar claims to public favour. This observation is made with reference to the disparaging remarks on other systems in Moon's 'Blind Readers and their Books.' Frere's publications are used in the Liverpool asylum; a society was also established at Blackheath some years ago for teaching the blind to read on Frere's system.

The price of these comparatively expensive books is a consideration which must not be lost sight of in any estimate of their respective claims on public notice. In another part of this article it is stated that a guinea was the sum proposed by Gall for a copy of the gospel of St. John; this, however, was the fancy price of an article new in itself, and for which there was no known market. All this is changed, as will be seen by a comparison of the prices annexed. The Gospel of St. John is now charged 4*s.* in Lucas's stenographic character; 4*s.* 6*d.* in Alston's Roman capitals: 8*s.* in Moon's arbitrary character. The book of Genesis is 8*s.* in Lucas's; 10*s.* in Alston's; 21*s.* in Moon's. The New Testament is charged 1*l.* 16*s.* in Lucas's; 2*l.* in Alston's; 4*l.* 17*s.* in Moon's. The Old Testament, 8*l.* 1*s.* 4*d.* in Lucas's; 7*l.* 15*s.* in Alston's; and 11*l.* 11*s.* in Moon's, without the books of Leviticus, Numbers, and 2 Chronicles; the addition of these will make the cost not less than 13*l.* 10*s.* This discrepancy in price is very great, and it is clear that Mr. Moon must reduce his prices to obtain that favour which he doubtless desires. How strange it is, however, that Alston's Old Testament in Roman capitals, without signs or contractions, can be had for less money than Lucas's with the aid of stenography and its very numerous contractions! Does stenography actually increase the bulk and expense of the books for the blind? The American books are much lower in price than any of the above; the letters are capitals and lower case, but so small that, in this country, they are considered unreadable by the blind. We have four systems in England, the Scriptures in each, besides many other books. And another character is projected. Mr. Littledale, himself blind, and the present superintendent of the school at York, proposes to bring out a "selected alphabet," made up of capitals and lower case letters, readable by any seeing instructor of a blind child; his strong impression being that the Roman character ought not to be set aside for one less universally known, and that no stenographic, or otherwise arbitrary alphabet, will meet the requirements of both children and adults for reading, writing, and accounts.

The writer of this article is not connected with any school for the blind; he does not wish to appear as a partisan of any system of typography for them, he has endeavoured to set forth the excellences and the defects of existing systems of printing, and to show the results as given by their respective advocates, while his wish is to see the superiority of a single system established, in order that the united efforts of all who are now engaged on methods so diverse may be combined for the production of good and cheap books for the blind. Enormous expenses have been incurred, chiefly by the benevolent public, in the purchase of the numerous founts of type, and in the establishment of several printing offices, where one would have sufficed if unanimity had prevailed. Each system has its adherents, but little good has been accomplished compared with such results as would have arisen from unity of purpose and willing co-operation. There cannot be a remunerating sale for the books produced on all the different systems. Zeal and benevolence may commence a good work of this nature, but it can only become an enduring benefit on the commercial principle. When this principle cannot be applied, zeal and benevolence will fail in providing heart-work and funds which must be so largely wasted. It may be a hard thing for men to sacrifice wishes long indulged and to forget objects for which they have lived and striven, but if the interests of the community, or of a class, require it, men of ardent and kindly feeling will not be backward in making such sacrifices. A conference should be held, partly composed of intelligent blind men, to ascertain whether it is possible to unite all parties in the prosecution of one system of printing, or whether all should persevere in a course which divides the friends of the blind and injures their cause. There are men living who have devoted years to the consideration of the question, and who would be glad to consider it by the lights of science and experience.

BLIND, CENSUS OF THE. In Great Britain and the islands of the British seas (exclusive of Ireland), there were 21,487 totally blind persons at the time of the last census—11,273 males and 10,214 females. Previous to 1851, no account had been taken of the number of the blind in Great Britain and Ireland, so that there are no means of ascertaining whether their number is increasing or decreasing relatively to the population. The numbers above given furnish a proportion of 1 in 975 in Great Britain, 1 in 979 in England and Wales, 1 in 960 in Scotland, and 1 in 837 in the Channel Islands and the Isle of Man. These proportions vary in different parts of the kingdom: in London the proportion is 1 in 1025, and it is nearly the same in the north midland, the south midland, the northern (including Yorkshire), and the south-eastern divisions of the kingdom; the west midland division presents us with 1 in 906; the eastern, 1 in 888; Wales, 1 in 847; and the south-western, 1 in 758: while the north-western district shows only 1 in 1167; the southern counties of Scotland, 1 in 1065; and the northern counties, 1 in 823.

On comparing these results with those obtained in other countries, we find that in the flat champaigns of Belgium, Hanover, portions of Saxony, Prussia, and some other German states, and the plains of Lombardy and Denmark, the proportion is 1 in 950; in the more elevated portions of Saxony, Prussia, Wurtemburg, Nassau, the duchies of Altenburg and Hesse, and also part of Brunswick, 1 in 1340; in Alpine regions, and countries elevated from 2000 to 8000 feet above the sea-level, as in some of the Swiss cantons, Sardinia, &c., 1 in 1500; while in Norway, according to the returns made in 1845, the proportion was 1 in 482. Thus the level portions of Europe present nearly the same results as Britain, while there are certain discrepancies in the above numbers which cannot at present be accounted for.

It has been thought that blindness has been increased by many of the employments followed in populous manufacturing towns; but it is clear, from the census returns, that a much larger proportion of blind persons is found in agricultural than in manufacturing and mining counties. For example, in Wilts, Dorset, Devon, Cornwall, and Somerset (south-western division), the average is 1 in 758; in Essex, Suffolk, and Norfolk, 1 in 888; and in the northern counties of Scotland, which include the Highlands, 1 in 823; while the highest proportion, namely, 1 in 665, is observed in Herefordshire. Contrasting these averages with the following manufacturing or mining counties, no unfavourable inference can be drawn as to the physical effects of manufactures on the sense of sight: in the West Riding of Yorkshire the blind are 1 in 1231; in Cheshire and Lancashire, 1 in 1167; in Durham, 1 in 1163; in Staffordshire, 1 in 1082. It should be remembered, that the asylums and schools which have been established for the reception and instruction of those deprived of sight are located in the principal cities and towns. Where, however, the towns are large, the number of inmates of these establishments only slightly affect the proportion which the blind bear to the general population. In London the proportion is 1 in 1025; in Manchester, 1 in 1107; in Liverpool, 1 in 999; in Birmingham, 1 in 1181. Conclusions unfavourable to the rural districts should not however be deduced from a mere comparison of the proportion of the blind to the population of all ages. Blindness is a common infirmity of old age; and an examination of the ages of the blind shows that nearly one-half of the persons deprived of sight are above 60 years of age. It follows, therefore, that in those localities in which the largest numbers of old men and women are living, the largest proportion of the blind will be found. In the great seats of manufacturing industry the population generally is much younger than in most of the agricultural counties where persons in large numbers, and especially females, are living, in circumstances favourable to longevity, at very advanced ages. Thus, in counties presenting the highest and lowest proportions of blind persons, the influence of age is sufficiently apparent. The proportion of population in Herefordshire aged 60 years and upwards is 10 per cent., while the proportion of blind of the same age is 61 per cent.. In Wilts, Dorset, Devon, Cornwall, and Somerset, the proportion aged 60 years and upwards on the whole population is 9 per cent.; on the blind it is 53 per cent. In Essex, Suffolk, and Norfolk, only 8 per cent of the whole population attain 60 years and upwards, while of the blind in the same locality, 50 per cent. attain this age. In the northern counties of Scotland, 9 per cent. of the population reach the advanced age specified; while of the blind, 54 per cent. attain the age of 60 and upwards. These four geographical divisions are those in which the highest proportion of blind persons

is found. The four divisions in which the lowest proportions prevail present a very striking contrast with the above. In the West Riding of Yorkshire, the proportion per cent. of the population aged 60 years and upwards is only 6, while the proportion of the blind of the same age is 43 per cent. In Cheshire and Lancashire, the proportion on the whole population is 5, that of the blind 31 per cent. In Durham, the proportion on the population is 6 per cent.; on the blind, 52. In Staffordshire, the proportion of the population is 6 per cent., and of the blind 42.

In the early ages of life the numbers of the blind are not large. Of the 21,487 blind persons in Great Britain, only 2929, or less than 14 per cent., are under 20 years of age,—a circumstance tending to show that cases of blindness at birth are not common. Between 20 and 60 years of age there are 8456 persons, or about 39 per cent. of the whole number; while 10,102 persons, or 47 per cent., are at the advanced ages above 60. These facts point to the conclusion that blindness, in many cases, may have arisen as a natural infirmity attendant upon old age, and also show the great longevity of the blind, notwithstanding the accidents to which they are liable.

It is clearly shown in one of the tables comprised in the Registrar-General's returns, that this affliction is not confined chiefly to particular classes and trades, but exists amongst all ranks and in a great variety of employments. None of the great branches of manufacturing industry seem to be peculiarly liable to it; indeed, the small numbers returned against cotton, linen, silk, woollen cloth, iron, and earthenware, are remarkable when the immense amount of labour employed in these manufactures is considered. Factory workers are however mostly young persons, and none would be employed in the midst of machinery with any defect of vision. Amongst the items which present the largest numbers in the classification of employments, are (in Great Britain): agricultural labourers, 907; labourers not otherwise described, 512; Chelsea pensioners and soldiers, 586; Greenwich pensioners, 70; farmers, 505; domestic servants (chiefly females), 438; weavers, 295; coal-miners, 195; copper- and lead-miners, 68; stone and limestone quarriers, 51. Of the class described as "annuitants," and "living on alms," there are 1062; and 2833 blind paupers are returned in workhouses without any statement as to previous occupation. Of the blind following employments presumed to have been acquired after loss of sight, there are: musicians and teachers of music, 535; mat- sacking- and net-makers, 127, and knitters, 92. With respect to 2853 males and 5960 females, no returns as to their actual or previous pursuits are made.

Of the persons returned as blind in Great Britain, 11,273 are males and 10,214 females. Accidents and diseases resulting in loss of sight are more likely to arise in the employments followed by males than in those of females. The proportions in England and Wales are 113 males to 100 females; in Scotland the difference is slighter,—a result probably traceable to the preponderance of aged women in that country.

The Census Report of the Commissioners on 'The Status of Disease' in Ireland is one of the most valuable documents ever published in this kingdom on the amount and distribution of disease. The inquiry was conducted with much intelligence, and with such precautions as are not usually manifested in matters of this nature. As a *first* contribution on the permanent maladies to which the inhabitants of a country are liable, its importance can scarcely be over estimated, while it has opened a field for investigation which will hereafter prove a source of lasting benefit to science, and which cannot fail to be a means of directing attention to the afflicted classes whose position it exhibits.

According to the returns made to the Census Commission Office, there were 7587 persons (3588 males and 3999 females) totally deprived of sight resident in Ireland on the 30th March, 1851. Of this number, 1672 were in the civic and 4920 in the rural districts, the former localities including the different asylums and public institutions for the blind; and 995 persons (373 males and 622 females) were in the various workhouses and auxiliary workhouses at the time specified.

Without an accurate medical examination and special inquiry into the circumstances of each case, it would not be possible to define or tabulate the diseases or accidents which produced the large amount of blindness ascertained. How many were born blind there are no means of knowing: congenital cataract, the most frequent cause of blindness from birth, is not very common; loss of sight from purulent ophthalmia and ulceration of cornea is the most common; and in some districts, particularly in the west of Ireland, internal inflammations of the eyes of a rheumatic character prevail to a great extent, and are a frequent cause of blindness.

The limited space we can devote to this subject prevents us from giving the important Tables included in the Report, from which we have drawn the above facts and observations. To that Report all who are interested in the state of the blind in Ireland may be referred. We give the heads of these Tables.

Table I. shows the number of blind in the civic and rural districts and the workhouses, together with the proportion of males to females, and proportion to the population in the several provinces, counties, cities, and towns in Ireland.

Table II. shows by ages and sexes the number and previous or present occupations of the blind.

Table III. shows by ages and sexes the state of education and marriage among the blind in workhouses and in the civic and rural districts.

Table IV. shows the number, distribution, means of support, date of erection, and other circumstances relating to the various asylums for the blind in Ireland.

Table V. (taken from the reports of St. Mark's Ophthalmic Hospital, Dublin, from 1844 to 1852) shows the varieties of diseases and accidents of the eye in 11,233 instances, together with the colour of the eye in 7354 cases.

(Compiled and extracted from the *Official Returns of the Census of Great Britain in* 1851, published under the authority of the Registrar-General; and from *The Census of Ireland for* 1851,—*Report on the Status of Disease.*)

BLIND, EDUCATION OF THE. Blindness perhaps meets with more general sympathy than any other calamity. Our most beautiful and correct perceptions are derived through the medium of sight; the want therefore of such a medium is an evil for which no other possession can compensate. Hence it is that we at first consider the blind as an unfortunate race, whose conceptions must not only be confined to that narrow sphere in which they live and move, but, as far as a knowledge of external objects is concerned, must be limited to that imperfect acquaintance which is obtained by the sense of feeling. Looking however further into the subject, we find that the sense of hearing is constantly communicating knowledge to a blind person which helps him to analyse and compare; from which he draws inferences, and arrives at conclusions more or less correct; that constant experience enables him to modify any false impressions which he may have received; that association, memory, and other powers of the mind are active; that the senses of smell and taste are continually contributing some small additions to his stores of knowledge; and that, by these united means, he may become well-informed on subjects of ordinary discourse, though labouring under a disadvantage at first appearance insurmountable. The self-education of a child born blind commences as soon as that of one who sees; and if parents in such cases would give themselves trouble in its instruction, instead of looking upon their case as one of despair, they would be amply rewarded by the improvement, surpassing all expectation, which their child would make. They would find little difficulty in communicating to him the names, shapes, and many other particulars of objects; and indeed language, with the exception of some classes of words denoting colour, or other qualities which can only be known by means of sight, might be as perfectly conveyed to him as to the child possessing all its senses. They would find that they could give correct ideas of numbers to a large amount by means of tangible objects, and of still larger numbers by analogy; that they could also give ideas of time, space, distance; so as to impress him with correct notions of the earth, its size, inhabitants, productions, climates; the occupations, the pleasures, and the pains of mankind. All this is knowledge of a useful and pleasing kind, and many parents would become highly interested in such a work; they would soon find that they might proceed still farther, and enable their blind child either to attain a certain degree of perfection in some mechanical art, or, by educating his higher faculties, train him to occupy a more intellectual and important station.

The parent who reasons and acts thus upon his child's calamity, will be supported and animated by the knowledge that he is supplying by his own attention the defect of nature, and that he is educating his child to fulfil important duties with the same pleasure to himself that others have who possess a more perfect organisation, and that he is providing a most efficient check to listlessness and mental torpor.

The ear has been happily called "the vestibule of the soul," and the annals of the blind who have become illustrious confirm the remark, for they show that few intellectual studies are inaccessible to them. It has even been said, and has received a kind of universal assent among those who have associated much with them, that in certain branches of study they have a facility which others rarely possess. The blind appear to have immense advantages over the deaf; their intercourse with the outward world, by means of speech, is more direct, and consequently more rapid, and their knowledge of passing events is equal to that of mankind generally. The deaf and dumb *see* indeed all that passes within their immediate sphere; but owing to the circuitous mode of communication which they have to adopt, they can know little beyond it, and enter very partially into the spirit of passing events. In addition to this, finding that they do not always understand perfectly, nor guess rightly, their temper becomes impatient, and their countenance acquires an anxious or irritable expression, which is sometimes mistaken for cleverness. We know of no deaf persons who have attained to any great degree of eminence, even under circumstances favourable to the development of their powers; but with regard to the blind, they have enriched the arts, the sciences, and literature by their successful pursuits, and not unfrequently under circumstances of extraordinary difficulty. Viewing both these classes of men as devoid of education, dependent upon themselves for support, and for the enjoyment of life, the blind are *physically* greater objects of compassion than the deaf, because, without peculiar modes of education suited to their privation, they cannot obtain a livelihood; but so far as happiness is dependent upon knowledge, and from this source some of the purest enjoyments arise, they are nearly on a level with ordinary men. Through the ear they can acquire knowledge of the highest order, and cannot

remain long in any company of their fellow-men without becoming in some degree wiser. The case of the deaf is the reverse of this; they are not *physically* so dependent as the blind: having the advantage of sight, they may apply themselves to and acquire the simpler imitative arts, and thus earn a subsistence, but *mentally* they are little above brutes; they can know nothing of the things around them, they feel themselves depressed and degraded among men; the language, the customs, the enjoyments of society, where these rise higher than what seems to exist among the more perfect animals, are to them unknown, and by them unregarded; and it requires only a small amount of reflection to perceive that an uneducated deaf person is not morally responsible for his conduct.

These remarks, and the comparison with which we have opened this subject, are not designed to show that the blind are less in need of education than the deaf and dumb; we are advocates for education in its fullest extent among all classes, but more particularly among persons who labour under impediments so distressing as those we have mentioned. Our advice would be to educate such persons as highly as possible, to improve especially those faculties which they appear to possess in a superior degree to mankind generally; but not to waste time and labour in endeavouring to instruct them in arts in which they can never attain to an equality with persons who possess the full enjoyment of their senses.

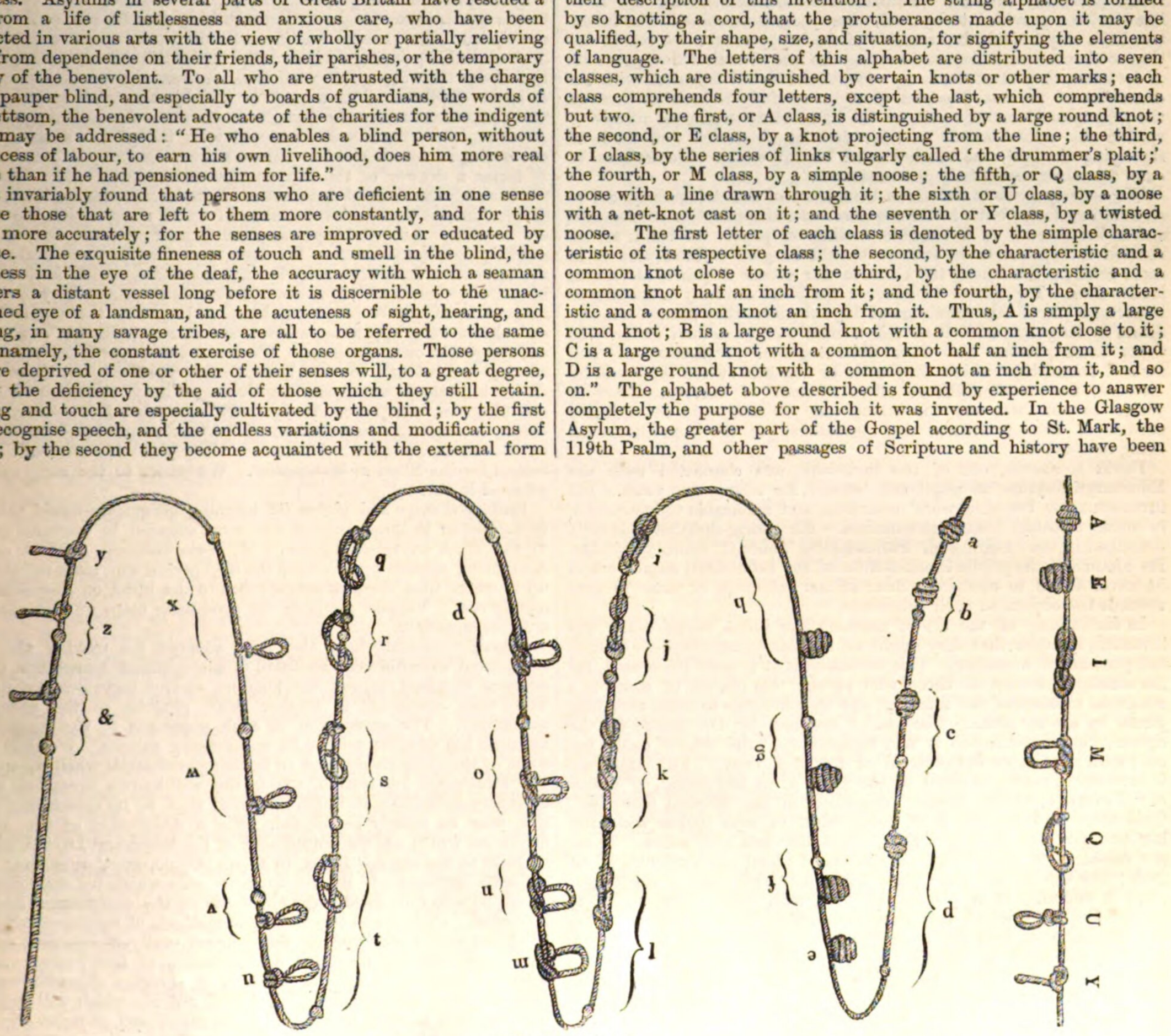
In this and in other countries, some attention has been paid to alleviate the sufferings and diminish the ignorance of the blind; the hand of kindness has been extended to lead them into society, and the voice of sympathy has been heard by them in the midst of their darkness. Asylums in several parts of Great Britain have rescued a few from a life of listlessness and anxious care, who have been instructed in various arts with the view of wholly or partially relieving them from dependence on their friends, their parishes, or the temporary bounty of the benevolent. To all who are entrusted with the charge of the pauper blind, and especially to boards of guardians, the words of Dr. Lettsom, the benevolent advocate of the charities for the indigent blind, may be addressed: "He who enables a blind person, without any excess of labour, to earn his own livelihood, does him more real service than if he had pensioned him for life."

It is invariably found that persons who are deficient in one sense exercise those that are left to them more constantly, and for this reason more accurately; for the senses are improved or educated by exercise. The exquisite fineness of touch and smell in the blind, the quickness in the eye of the deaf, the accuracy with which a seaman discovers a distant vessel long before it is discernible to the unaccustomed eye of a landsman, and the acuteness of sight, hearing, and smelling, in many savage tribes, are all to be referred to the same cause, namely, the constant exercise of those organs. Those persons who are deprived of one or other of their senses will, to a great degree, supply the deficiency by the aid of those which they still retain. Hearing and touch are especially cultivated by the blind; by the first they recognise speech, and the endless variations and modifications of sound; by the second they become acquainted with the external form

of objects. The chief art of the instructor of the blind therefore consists in supplying through an indirect medium those ideas of which his pupil cannot obtain a conception through the ordinary channels; and in doing this he will act wisely to ascertain what ideas on kindred subjects his pupil possesses, whether such are true or false, and by what process he became possessed of them; to become, in fact, the pupil of his pupil; to draw forth the stock of knowledge already attained, in order to form a ground-work on which to proceed with his future instructions.

The mode which would probably first occur to a teacher in the intellectual education of the blind would be lessons delivered orally, illustrated by such analogies as would enable them to follow their teacher, taken, if necessary, from objects appealing to their senses. At first they would advance by slow degrees in comparison with pupils who see, but this very slowness would be accompanied by a sureness which would amply repay the pains taken to make the lessons understood. It is a fault in ordinary schools that the first steps are taken too rapidly, and one advance too quickly follows upon a former. Such schools might derive a useful lesson from the methods used in the instruction of those who are deprived of one or other of their senses. From oral instruction, the transition to a palpable language is natural. Accordingly, we find that the invention of *characters in relief* was among the earliest measures taken for instructing the blind. [BLIND, ALPHABETS FOR THE.]

An ingenious *string alphabet* was contrived a few years ago, by David Macbeath, a blind teacher in the Edinburgh School, in conjunction with Robert Milne, one of his blind companions. The following is their description of this invention: "The string alphabet is formed by so knotting a cord, that the protuberances made upon it may be qualified, by their shape, size, and situation, for signifying the elements of language. The letters of this alphabet are distributed into seven classes, which are distinguished by certain knots or other marks; each class comprehends four letters, except the last, which comprehends but two. The first, or A class, is distinguished by a large round knot; the second, or E class, by a knot projecting from the line; the third, or I class, by the series of links vulgarly called 'the drummer's plait;' the fourth, or M class, by a simple noose; the fifth, or Q class, by a noose with a line drawn through it; the sixth or U class, by a noose with a net-knot cast on it; and the seventh or Y class, by a twisted noose. The first letter of each class is denoted by the simple characteristic of its respective class; the second, by the characteristic and a common knot close to it; the third, by the characteristic and a common knot half an inch from it; and the fourth, by the characteristic and a common knot an inch from it. Thus, A is simply a large round knot; B is a large round knot with a common knot close to it; C is a large round knot with a common knot half an inch from it; and D is a large round knot with a common knot an inch from it, and so on." The alphabet above described is found by experience to answer completely the purpose for which it was invented. In the Glasgow Asylum, the greater part of the Gospel according to St. Mark, the 119th Psalm, and other passages of Scripture and history have been



The String Alphabet.

executed in this alphabet. The knotted string is wound round a vertical frame, which revolves, and passes from the reader as he proceeds.

This alphabet reminds us of the *Quipos*, or knot-records of Peru, in which the history of their country was recorded long before the discovery of America by the Spaniards. Their *quipos* were formed of the intestines of animals, and there is a similar diversity in their symbols with that in the string-alphabet of which we are speaking. An account of these quipos was published in London in 1827. They were purchased by Alexander Strong for ten pounds, from a person who bought them at Buenos Ayres.

In further explanation of the string-alphabet the inventors say, "It

must readily occur to every one that the employment of an alphabet composed in the manner which has been explained, will ever be necessarily tedious; but it should be borne in mind that there is no supposable system of tangible figures significant of thought, that is not more or less liable to the same objection. The inventors are aware that among the different methods by which people at a distance might be enabled to hold mutual intercourse through the medium of a language addressed to the touch, there are some that would doubtless be more expeditious than theirs; but they flatter themselves that, when all the advantages and disadvantages of each particular method are duly considered, the plan which they have been led to adopt will appear, upon the whole, decidedly the best. There can scarcely be any system of tangible signs, which it would be less difficult either to learn or to remember; since a person of ordinary intellect may easily acquire a thorough knowledge of the string-alphabet in an hour and retain it for ever. Yet the inventors can assure their readers that it is impossible for the pen or the press to convey ideas with greater precision. Besides the highly important properties of simplicity and accuracy which their scheme unites, and in which it has not been surpassed, it possesses various minor, nor yet inconsiderable advantages, in which it is presumed it cannot be equalled by anything of its kind. For example, its tactile representations of articulate sounds are easily portable—the materials of which they are constructed may always be procured at a trifling expense—and the apparatus necessary for their construction is extremely simple. In addition to the letters of the alphabet, there have been contrived arithmetical figures, which it is hoped will be of great utility, as the remembrance of numbers is often found peculiarly difficult. Palpable commas, semicolons, &c. have likewise been provided to be used, when judged requisite. The inventors have only to add, that sensible of the happy results of the invention to themselves, and commiserating the fate of their fellow-prisoners of darkness, they most earnestly recommend to all intrusted with the education of persons deprived of sight carefully to instruct them in the principles of orthography, as the blind being in general unable to spell is the chief obstacle to their deriving, from the new mode of signifying thought, the much-wanted benefit which it is designed to extend to their melancholy circumstances."

We entirely agree in the views here taken of the string-alphabet; as an auxiliary to the blind in the acquirement and application of language, and in the absence of a tangible writing on paper, we think no invention is superior to it, and we should be glad to have seen it in more common use among the blind in our recent inquiries at various institutions. The advice to instruct the blind carefully in spelling is important; for if this acquirement be not made, they cannot communicate by language with their fellow men otherwise than orally. To those blind persons who have lived together in institutions, and formed friendships which they wish to continue when separated by distance, the string-alphabet offers a mode of correspondence as perfect as our pen, one too which may be intrusted to ordinary persons to convey without any probability of the communication being deciphered.

David Macbeath, one of the inventors, was connected with the Edinburgh Asylum, as pupil and teacher, for twenty-five years. His inventions for teaching were numerous, and applicable to instruction in music, arithmetic, and mathematics. His string-alphabet was fully described in the 'Edinburgh Philosophical Journal,' some years ago. He conducted the public examinations of the Edinburgh pupils, where he never failed to excite the interest and attention of those present towards the objects of their solicitude.

In the infancy of the art of teaching the blind, *raised music* was invented, in order that they might be enabled to acquire their lessons independent of a master. This invention is at present little used, for the constant practice of those who pursue this branch of study is a continual exercise of the memory, and they are able to learn very long pieces by the ear alone. The reason assigned by Dr. Guillié for the disuse of embossed music is very satisfactory, "the scholar could not read with his fingers and perform at the same time." Thorough bass is however as readily studied by the blind as by the seeing, by means of "Tansure's Musical Board," described in his 'Musical Grammar.' This board is three feet long, about eight or nine inches wide, and has two staves, with ledger lines, above, between, and below. These are raised upon the surface of the board about one-sixteenth of an inch; the top of the stave lines being flat, while that of the ledger lines is round. It is pierced all over with little holes, so as to receive the pins, which represent the notes. We may here mention the invention of Don Jaime Isern, the object of which is to enable a blind composer to transfer his thoughts to paper in the usual musical notation, without the necessity of employing an amanuensis. For this invention the large silver medal of the London Society for the Encouragement of Arts, Manufactures, and Commerce was given to Don J. Isern in 1827. There is a full description of it, with illustrative engravings, in vol. xlv. of the 'Society's Transactions.' In the same volume there is an interesting communication on the subject of types for the blind, by Mr. G. Gibson of Birmingham. This communication is connected with various inventions which we have had the pleasure of inspecting, and of which we shall give a short account, referring our readers who desire to be made perfectly acquainted with the invention to the work above mentioned. Mr.

Gibson's aim has been to supply the blind with a mode of writing and keeping their own accounts. "A cube of wood, or of any other convenient material, the size of which will depend on the delicacy of touch in each blind person, is to have raised on one side of it a letter, or figure, or stop, in the manner of a printer's type. On the opposite or lower side of the cube is a representation of the same character as is on the upper side, but formed of needle-points inserted into the wood. If therefore a piece of paper be laid on a cushion, or surface of felt, and the type be pressed down, the points will enter the paper, and form on the under surface of it a raised or embossed representation, by the projection of the burs where the points have penetrated, and this embossed character may be distinguished, and consequently read by the touch." In its outward appearance, the whole apparatus of Mr Gibson forms a small piece of cabinet furniture. When the top is thrown open an even surface of cushion presents itself. Upon this there is a flat piece of mahogany about an inch broad, which can be moved from one notch to another, to any part of the desk. This is for the letters to lie against, like the composing-stick of a printer. The letters he uses are a composition of tin and lead; the upper surface is elevated so that he can distinguish the letter, and the under surface has inserted in it needle-points of the shape of the letter on the upper surface. In writing the Lord's Prayer, after the paper is placed, he takes O out of its division, and puts it at the beginning of the line, then U, then R, gently pressing each letter down, as he puts it next the preceding one. At the end of a word he inserts a small mahogany space, and proceeds till his performance is complete; whether it be a copy of anything which he wishes to make, or an original piece of composition. It will be observed that, by putting two or more pieces of paper underneath his pointed types, copies will be multiplied. The letters are in small divisions, which occupy side-drawers in his printing cabinet. The use of this machine implies more knowledge than the uneducated blind possess, as they must know how to spell. However, it is a part of its object to teach spelling. For this communication to the London Society for the Encouragement of Arts, &c., Mr. Gibson was presented with the gold Vulcan medal of the Society. Another of Mr. Gibson's inventions may be here noticed. It forms a drawer of the cabinet above-mentioned, and is intended for working the rules of arithmetic. This Mr. G. calls his slate. It is divided into rows by elevated slips of wood, along which the figures are to slide. Like the types they are formed of metal, but have no needle-points underneath. We have seen him perform examples in multiplication and other rules by this apparatus, which is simply and beautifully conceived. It is obvious that all the elementary operations in arithmetic may be performed by it, and that by the union of this and the writing apparatus, a blind person may write his own letters, and keep his own accounts. We have dwelt upon the subject of reading and writing for the blind, feeling that they are deserving of all the importance which can be attached to them. Lieutenant Holman, the blind traveller, used Wedgwood's apparatus for writing in the dark. A very ingenious instrument of this nature has been invented by the late Mr. Hughes, who was for many years the governor of the School for the Blind at Manchester. We return to the early methods pursued in this art.

Embossed maps and globes for teaching geography would naturally be suggested to those persons who were engaged in teaching reading to the blind by raised figures. M. Weissembourg, a blind man of Mannheim, appears to have been the first person who made relief-maps; up to which time the instruction given to the blind on geography was merely oral. Various methods for producing maps of this character are now employed.

Palpable methods have also been adopted for making the blind acquainted with different branches of astronomical knowledge, and, in addition to raised maps of the heavens, various ingenious instruments have been contrived to further their progress in the science of astronomy. The application of such apparatus to the purposes of teaching has been attended with encouraging success. We shall detail some of the methods pursued in teaching arithmetic when we speak of the Edinburgh Institution, where the well-known invention of Dr. Saunderson has been so much improved that, by its means, any operation may be readily performed. For a description of the original invention, which was the united work of Dr. Moyes and Dr. Saunderson, we refer to the article 'Blind' in Rees's 'Cyclopædia,' or in the 'Encyclopædia Britannica.' By the improvements which we shall describe, it will be seen how greatly the simplicity of the contrivance has been increased. Previous to these tangible methods of teaching arithmetic the blind were instructed on this subject orally, the process on their part being entirely mental. A publication of late years, which is intended exclusively for the blind, is of a higher character and aim than any that have preceded it, though not one which will generally be considered as equal to many of those mentioned, in point of utility. The work to which we allude is an elementary treatise on mathematics by the Rev. William Taylor of York, called 'The Diagrams of Euclid's Elements of Geometry, arranged according to Simpson's edition in an embossed or tangible form, for the use of blind persons who wish to enter upon the study of that noble science,' York, 1828. As a means of leading to the acquisition of a science for which some blind persons have shown a predilection, this beautifully executed work is of great value, and we hope that the blind generally who show a superior

aptitude for the exact sciences, even though instructed in a degree at the public expense, will have all the advantages which works like Mr Taylor's aided by good instructors can confer. It is stated that some of the pupils of the London School for the Indigent Blind worked a few problems for Mr. Taylor, their examiner, at their examination last Christmas.

Institutions of a philanthropic tendency have frequently originated with members, individual or collective, of learned societies; and such societies have lent their assistance and patronage to various efforts for advancing the condition of mankind, and removing the obstacles to improvement. The attempts of M. Haüy to systematise a plan for the education of the blind are the first which are deserving of especial notice. His methods were submitted to the Academy of Sciences of Paris, where they received all the encouragement he looked for. The commissioners chosen to report upon the means which he proposed to employ suggested to the Academy not only to bestow its approbation upon M. Haüy, but also to invite him to publish his methods, and to assure him of their readiness to receive from him an account of his future progress. It appears that many of the plans recommended by Haüy in his 'Essay on the Education of the Blind,' were not so much his own inventions as adaptations of the ingenious contrivances of individuals of different ages, and in different countries, who had preceded him in this benevolent work. The celebrity of certain blind individuals, partly the result perhaps of pains-taking teachers, and partly of their own highly gifted minds, had reached the ears of Haüy. By a happy exercise of benevolence and talent, aided by that enthusiasm without which the greatest labour is ineffectual, he formed the outline of a system of instruction, which required only time, and the modifications which discover themselves in every course of rational teaching, to be brought into successful operation. He wished to make the sense of touch do that for the blind which the Abbé de l'Epée had made the sense of sight do for the deaf and dumb. He wished to see the fingers of the blind employed in reading written language, and for this purpose he invented the noble art of printing in relief, which will hand down the name of Valentine Haüy with honour to posterity. Haüy offered to instruct gratuitously the blind children who were under the care of the Philanthropic Society. He commenced his instructions in 1784, and taught his pupils reading, writing, arithmetic, geography, composing types, and printing. In 1786 public exercises were performed by the pupils at Versailles, in the presence of the king; these exercises excited much astonishment, and there seemed to be little doubt of the stability and success of the undertaking. Large funds were subscribed, and the school was filled with pupils; but the commencement had been made on a scale too extensive for its regular maintenance, the warmth of popular feeling cooled, and as the institution was unsupported by government, Haüy never enjoyed the fruits for which he toiled. His school was not however suffered to fall entirely; it was taken up by the Constituent Assembly of the Revolution, and has since been supported at the expense of the government. The establishment of which we are speaking is the School for the Young Blind at Paris.

There are at Paris two celebrated institutions for the blind. The more ancient of these is the Hôpital Royale des Quinze Vingts, founded by St. Louis in 1260, for the reception of such of his soldiers as had lost their sight in the East. At its first establishment it consisted of *blind* and *seeing* persons, the latter being the conductors of the former. As its name indicates, it receives *fifteen score*, or three hundred blind persons. This noble asylum continues, as it was originally placed, under the government of the grand almoner of France. To obtain admission it is necessary that applicants be blind and indigent; they are admitted from all parts of the kingdom, are lodged in the hospital, and receive twenty-four sous (about a shilling) a day for their food and clothing. No instruction is afforded to the inmates of the Quinze Vingts; some of them, however, execute works, which, for their ingenuity, attract and deserve attention. The other Parisian establishment for the blind is the Institution Royale des Jeunes Aveugles, of which Haüy was the founder. It contains about a hundred young persons of both sexes, who are maintained and educated at the expense of the state for eight years. Paying pupils are also admitted. During the last quarter of a century the education of the blind has made great advances, as will be seen when the present state of the various establishments is compared with their actual condition, as described in the article BLIND of the 'Penny Cyclopædia.' The writer of that essay lamented that there was so much that appeared to him censurable, and that called for animadversion in the modes of education pursued in some of the schools for the blind. The article was, however, transmitted to three of these schools previous to its publication, and it was allowed to be a correct statement of facts. A great change for the better has since taken place, not only in the schools referred to, but in others also; new asylums have been established, and the attention of many experienced men has been directed to various branches of education, and especially to the provision of books in raised type, of which an account is given in the article BLIND, ALPHABETS FOR THE.

The first British Asylum for the Blind was established at Liverpool, in the year 1791. This institution has hitherto been liberally supported. During the year 1858, its expenditure was 3000*l.*, its income about 3400*l.*, derived from goods disposed of (the work of its inmates), from the payments made on behalf of the pupils, from legacies, donations, and subscriptions, from dividends, and the pew-rents of its chapel. The sums received for articles manufactured exceeded 900*l.*, but the produce of these labours does not assist the funds of the establishment. The instruction of the blind in manual labour seems to be the primary object with the directors of the institution. The trades which are taught are those of basket-making, rope-making, weaving, shoemaking, sewing, knitting and platting sash-line. The most profitable of these arts is the rope-making; the locality of the institution contributes to the advantages derived from this trade. The sugar-houses require so vast a supply of cordage, that it can scarcely be furnished in a sufficient quantity. The next most profitable labour is the weaving of carpets, lobby-cloths, and bear-rugs. Masters possessing sight are regularly employed in teaching the various trades; the reasons why the institution derives no pecuniary advantage from the extensive labours carried on are sufficiently obvious when the expense of experienced masters is considered, the waste of materials by the labourers who are chiefly learners, and their quitting the asylum when they can earn enough to maintain themselves.

The total number of persons who have been received into this asylum from its commencement to the publication of the report, January 1859, was 1429. Some very interesting details are given in the same document on the causes of the calamity under which the pupils labour, so far as could be ascertained by the officers of the institution.

LIVERPOOL INSTITUTION, TOTAL NUMBER RECEIVED 1429.

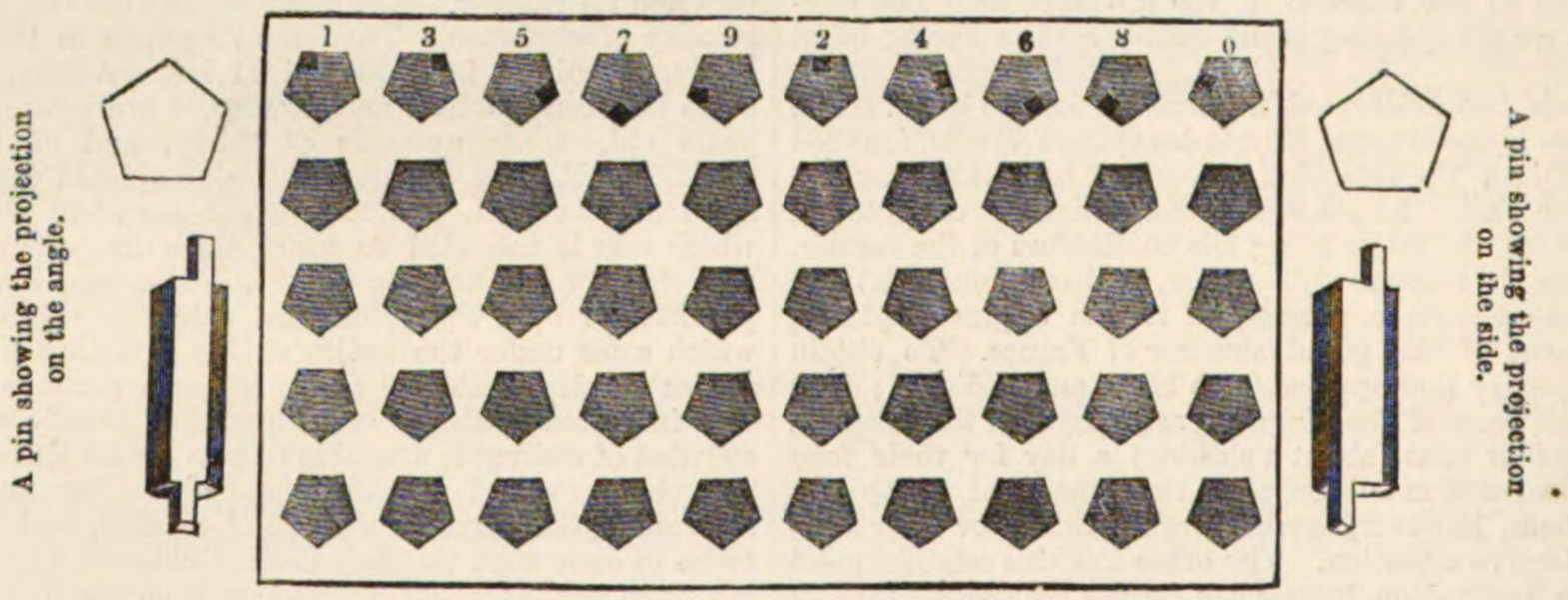
	Totally.	Partially.	Total.
Blind from their birth	70	49	119
" " small-pox	202	48	250
" " inflammation	278	177	455
" " cataract	56	93	149
" " external injury	99	47	146
" " defect in the optic nerve	76	64	140
" " amaurosis	25	15	40
" " imperfect organisation	6	14	20
Lost their sight at sea	8	1	9
" " by gradual decay	5	3	8
" " after fever	14	5	19
" " after measles	8	5	13
" " after convulsions	3	3	6
" " from causes not mentioned, or imperfectly described	28	27	55
	878	551	1429

From the reports of the Liverpool Asylum, as well as from others which we have seen, the blind seem to be pretty equally scattered in all parts of the kingdom. Of the 1429 persons who have been inmates of the Liverpool Asylum, 225 have belonged to Liverpool, 294 to other parishes in Lancashire, and 910 to distant parts of the kingdom. A large proportion of the income of the institution is derived from Liverpool and its vicinity. The blind of that district have therefore a just priority of admission. There are 79 pupils in the Liverpool Asylum; 18 were admitted in 1858, and 21 left. Among those thus admitted, 8 are between fourteen and twenty, 4 are between twenty and thirty years old, 4 are upwards of thirty, and of 2 the ages are not specified. Most of those who have completed their education receive a gratuity of from two to five guineas when they quit the asylum, which sum is intended to assist them in procuring a few tools and materials for commencing the trades they may have been taught. This provision is both benevolent and wise; for there are numerous cases which come under the notice of the directors where poverty accompanies the deprivation of sight, and where, consequently, the instruction imparted would be of no practical benefit were not some means afforded of making it available to provide for their common necessities. The observances of religion appear to be regularly regarded: prayers are read in the chapel morning and evening, and the chaplain attends twice in each week to teach the catechism. The appointed hours for labour in the Liverpool Asylum are from six in the morning to six in the evening, one hour being allowed for breakfast and recreation, and another for dinner. Some of the pupils occupy a large portion of their time in the practice of music, singing, reading, &c. Frere's system of raised type is used, but the superintendent is not prepared to say which of the several series of books is most eligible for the blind. There are no fixed hours for acquiring the art of reading by touch, but instruction is given at such times as the teachers can spare from their other duties. Many of the inmates are middle-aged adults, whose object in entering the institution is expressly to acquire facility in some employment by which they can maintain themselves, and who leave as soon as they have succeeded in learning a trade, some of them only remaining under instruction from six to twelve months. This information has been supplied by the superintendent.

In the year 1792 an Asylum for the Blind was established in Edinburgh. The benevolent Dr. Blacklock, who resided in that city many years, had long anxiously wished that such an establishment should be formed for the education of those persons who, like himself, were deprived of sight. He mentioned his wishes to his friend Mr. David Miller, who was also blind, and was himself an eminent example of what might be effected under the influence of early and judicious instruction. In the year mentioned, it was determined by Mr. Miller and the Rev. Dr. David Johnston, of Leith, that an attempt should be

made to provide an asylum, and means were taken to call public attention to the object. Mr. Miller communicated with the Abbé Haüy, and in many ways rendered important services during the infancy of the institution. The chief end in the formation of the contemplated asylum, next to imparting ordinary instruction (orally, it is presumed), and imbuing the minds of the objects with religious truth, was to place them under such superintendence as should train them in those trades in which the blind "are best fitted to excel;" at the same time rewarding them for their labours according to their progress and proficiency. In later years the directors of the asylum have extended their views, devoting increased attention to the intellectual culture of the pupils; but still the main object appears to be that of training them to habits of manual labour. The economical character of the Edinburgh Asylum must be a striking feature to all who compare its expenditure, considering the amount of good it accomplishes, with that of similar institutions. We have frequently heard of the excellent management of the public charities of Edinburgh; but in none is such management more visible than in this. In 1806 the directors formed a separate establishment for females, and since that time they have opened a school for the instruction of the young blind. It is by early training only that the blind, in common with others, can be brought under an effectual mental and moral discipline. By giving instruction to the young in the higher departments of knowledge, and by thus raising the intellectual character to the elevation of which it is capable, we are of opinion the directors will discover that the arts in which the blind are best fitted to excel are not the ordinary mechanical trades, to which, in our British institutions, and too generally abroad, all higher considerations have been sacrificed. Why are not their mental powers, which are unaffected by their physical calamity, cultivated? Such cultivation will qualify them for occupations in which they may succeed as well as those who possess the advantages of sight. The enlightened policy of the directors of the Edinburgh Institution has placed them in the first rank among the benefactors of the blind: their school for the young is a most interesting section of their establishment; and it may be hoped that many of its pupils will be trained to higher occupations than those of basket-making, weaving, &c. We do not anticipate that all the blind can be exempted from manual labour, any more than that all other men are fitted for employments requiring a high degree of intellectual vigour, and acquirements which even the greater portion of mankind are unable or unwilling to make: but we do not hesitate to affirm that the blind have been systematically trained in arts in which they never can enter into competition with seeing persons; and that they have not been sufficiently educated in that kind of knowledge in which they might have become at least as perfect as those who possess all their faculties. The former part of our proposition is allowed by the directors of the Edinburgh Asylum, who say that "when they (the blind) become as skilful workmen as their circumstances admit, they still labour under a disadvantage unknown to others." An argument which might with great propriety be used to enforce the advantage of mental cultivation in preference to manual dexterity, is the loss invariably attendant on the manufactures carried on at the asylums. It appears to us from our examination into the expenses of different establishments, that the more extensive the scale on which the manual arts are conducted, the greater the losses, from waste of materials, a succession of learners, &c. On the score of cheapness therefore it is desirable that such operations should be confined within as narrow limits as may seem prudent, and that intellectual education should be extended as widely as the talents and qualifications of the pupils will allow. Instead of the accounts of such institutions showing so great an amount of positive losses, we should not only see this item reduced, but find the pupils qualified for a sphere of usefulness superior to any which they can ever reach by any attainable degree of dexterity in manual occupations.

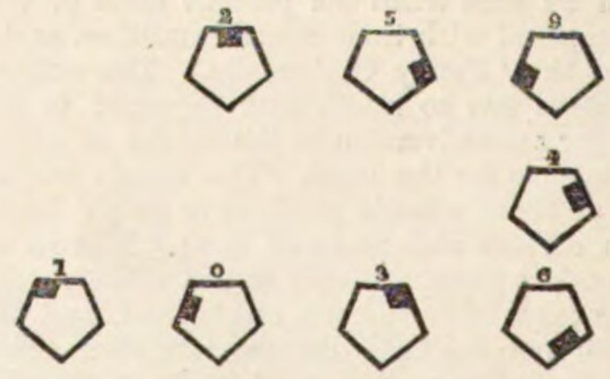
In the Edinburgh Asylum, the whole machinery seemed to be of a high order; the devoted attention of the different officers is visible in the discipline and happiness of the inmates, and there can be no doubt that the institution is effecting great good. The young blind are instructed in reciting the scriptures, in spelling, in grammar, in vocal and instrumental music, in reading, by means of the sense of feeling; in writing, arithmetic, mathematics, history, geography, and astronomy. The means by which instruction in these various branches is conveyed have been mentioned; in all institutions of this nature they must be generally the same, varying perhaps in some of their details. Several of the mechanical contrivances for conveying scientific knowledge to the pupils are the inventions of Mr. Johnston, the former secretary (nephew of Dr. Johnston, who was named as one of the founders of the institution), in conjunction with Professor Wallace, a gentleman who was deeply interested in all that concerned the institution. An orrery, a cometarium, and raised maps of the heavens, all so constructed as to convey information by the touch,—while the reasoning powers are at the same time addressed,—are among the inventions of these gentlemen. The map of the world is described as comprising "the eastern and western hemispheres, represented on each side of a circular board. The land is made rough, the seas, lakes, and rivers smooth. Towns are represented by small pins. Mountains are ridged, and boundaries simply raised. Degrees of latitude are marked round the edge of the circle, of longitude along the equator, which is raised above the surface of the earth. The orrery represents the orbits of the planets by brass circles, and the planets themselves are shown by spheres indicative of their relative dimensions; the spheres slide upon the brass orbits. The ecliptic exhibits raised figures of the signs of the zodiac, the degrees of the circle, and the days of the month, all tangible, and adapted to the learner who has to depend upon touch for his impressions. The *arithmetic board* is 16 inches by 12, and contains 400 pentagonal holes with a space of a quarter of an inch between each. The pin is simply a pentagon, with a projection at one end on an angle, and on the other end on the side. Being placed in the board, with a corner projection to the left upper corner of the board, it represents 1; proceeding to the right upper corner it is 3; the next corner in succession is 5; the next 7, and the last 9. In like manner the side projection, by being turned to the sides of the hole, progressively gives 2, 4, 6, 8, 0. The size of the pentagon, and a drawing of the pin, showing the projections on the side and angle, are given with the board above.



The Arithmetic Board.

By the use of this board the pupils may be carried to any extent in arithmetical knowledge, and make their calculations with as much satisfaction as those who see. The last improvements in the Arithmetic Board were made by William Lang, at first an inmate of the Edinburgh Asylum, afterwards of that of Glasgow. Further to illustrate its use an example is given below of a sum in multiplication, which will be at once understood on comparing it with the board above; this example shows $259 \times 4 = 1036$. The pentagons represent the pins with their projections as supposed to be in the holes of the Arithmetic Board.

We have the testimony of Dr. Guillié, that the blind study the exact sciences under great advantages, and with remarkable success; but we cannot agree with the doctor that the blind, any more than *les clair-voyans* have a natural disposition for mathematical studies. The eminent success of Saunderson, Moyes, Gough, and others, afford sufficient proof that blindness is no great impediment to such pursuits;



there may possibly be some advantages consequent on the degree of abstraction which appears necessarily to accompany blindness. On this supposition however we do not lay much stress, because we cannot admit that there is *naturally* any compensative principle by which men who labour under one defect or deprivation, are enabled to exercise the powers which are left to them with greater accuracy than others

who have no such deficiency. If a seeing person would cultivate his sense of feeling to the same extent as the blind, his perceptions of touch would be as delicate as those of the blind man. It is not probable that so refined a cultivation will ever be tested by experience, as it would require a greater degree of philosophical curiosity than we ever witnessed or heard of, and be attended with a longer and more painful effort than we think any one would voluntarily undergo for the sake of making the experiment.

The Bristol Asylum for the Blind owed its origin to the benevolent exertions of two members of the Society of Friends, Messrs. Bath and Fox. It was opened in 1793, in a disused Baptist meeting-house. After attempting several of the trades, basket-making was commenced, and although other occupations are followed, fine and coarse baskets have been the staple manufacture of this asylum to the present time. In 1803 its funds were so greatly increased that the committee of management were enabled to spend 1800*l.* on the purchase of premises in Lower Magdalen Lane, and its operations were there carried on till its removal in 1838 to the present eligible situation at the top of Park Street, where a building was erected in the early English style, with a chapel in architecture of a later character, and became a prominent ornament to the city. This building provides workshops for 100 pupils, and bedrooms for 70. At a subsequent date, rooms were added for washing, baths, and shower-baths, and a more recent purchase of land in Tyndall's Park gives ample room for exercise and amusement. If the utility of the asylum may be deduced from the progressive increment of the sales the conclusion will be satisfactory, as in 1794, its second year, their amount was 18*l.* 8*s.* 6*d.*, and in the year ending 1857 there was received "for baskets, table-mats, flower-stands, hearth-rugs, door-mats, and knitting, 1088*l.* 2*s.* 2*d.*"

The distribution of time in mental occupation and manual labour is as follows:—The pupils rise at 6 a.m., and work or take exercise till breakfast at 8 o'clock; at half-past 8 prayers are read by the master; the school-room is then occupied from 9 to 6, the classes being changed every hour. By this arrangement each pupil receives two hours' instruction daily. One hour in the day is allotted to musical practice, two hours' instruction being given to each pupil every week; the remaining time till 6 o'clock is occupied in manual labour, and, as occasion offers, the master or matron reads to the pupils while at work; but three days in the week they read collectively. On two evenings the pupils assemble for practice with the music-master, and the remaining evening they attend the chaplain for religious instruction. Supper is served at half-past 7; immediately after prayers are read by the matron, and the household retires to rest about 10.

Instruction in the Bristol Asylum is conducted by a chaplain; by the master, who teaches reading, arithmetic, geography, and history, and who has a blind assistant of either sex; by a music-master, with similar aid; by a basket-maker for the men, who has also two blind assistants; and by a female basket-maker, with one assistant possessed of sight and one who is blind. Great advantage is thought to be obtained by this employment of blind teachers, especially in the initiation of new pupils. The system of printing preferred in this asylum is that in the Roman character, by the late Mr. Alston of Glasgow. The books published by that gentleman were introduced in 1837, and have continued in daily use to the present time. A 'Life of James Watt,' an 'Elementary Geography,' 'Our Lord's Sermon on the Mount,' and a 'First Reading Book,' have been published at this institution in Roman capitals and lower case.

The report of the chaplain on the scriptural instruction of the pupils is very satisfactory. The report from which we quote states that nine of the younger ones had received confirmation, five of whom had become communicants. The master's report to the committee on their secular instruction is equally satisfactory: biography, history, arithmetic, grammar, and geography are the subjects of his statement; while the music-master considers the progress of some and the proficiency of others in music and singing as deserving commendation. All who are engaged in the management speak of the pupils as intelligent and well-disposed, and as manifesting a spirit of cheerful obedience. The welfare and conduct of the former pupils is not overlooked in the report of the committee: special instances are recorded of some of the advantages the asylum has conferred on individuals, and it is also stated that satisfactory accounts continue to be received from others, who, from the trades they learned and the industrial habits they acquired while at the asylum, are now earning a living in such a manner as not only to reflect credit upon themselves, but also on the institution. There are in the Bristol Asylum 66 pupils: males, 42; females, 24; upwards of 40 of them are under 20 years of age.

The School for the Indigent Blind in London was established in 1799 by four gentlemen of the metropolis,—Messrs. Ware, Bosanquet, Boddington, and Houlston. At first the pupils were few, and it did not attract any extraordinary share of public attention. About eleven years after its formation, the patronage of the public enabled the managers to take on lease a plot of freehold ground in St. George's Fields, opposite to the end of Great Surrey Street, where suitable buildings were erected, within which the institution is still carried on. An Act of Parliament was obtained in 1826, which invests the committee with all the rights and privileges of a corporation, and they then purchased the freehold of the ground on which the buildings had been erected. These buildings were found insufficient for the purposes of

the establishment, and the committee purchased an adjoining plot o ground, upon which a new and enlarged building is erected. In 1800 there were only 15 persons in the asylum: the present number of inmates is 154,—78 males and 76 females. The inmates are "clothed, boarded, lodged, and instructed." The funds of the charity are ample. The receipts have seldom exceeded the expenditure. In addition to its annual subscriptions, donations, and legacies, it possesses a funded capital amounting to above 80,000*l.*, besides other available property. The articles manufactured by the females are, for sale, fine and coarse thread, window sash-line and clothes-line, fine basket-work, ladies' work-bags, and other ornamental works in knitting and netting; for consumption by the pupils, knitted stockings, household linen, and body linen. The occupations of the males are making shoes, hampers, wicker-baskets, cradles, rope-mats, fine mats, and rugs for hearths and carriages. These articles are sold at the institution, and it is said that the window sash-line is highly approved of by builders of the first eminence. The sale of articles manufactured during the year 1857 produced 815*l.*

An extraordinary change has taken place in the educational aspect of this establishment in the lapse of the last twenty-five years; its chief object at that time was instruction in manual labour; a few of the pupils were taught music, but the attempt to teach reading and writing had been abandoned from the unwillingness of the inmates to receive instruction. The recent reports contrast most favourably with those of former years. Not only are the pupils carefully instructed in the principles of the Christian religion, including the Holy Scriptures, and in vocal and instrumental music, but the following secular subjects are also well taught: namely, reading, writing from dictation, history, and geography; the emulating test of half-yearly examinations is also applied to this part of their education, and their inspectors in successive years (the Rev. J. D. Glennie and the Rev. W. Taylor) reported most favourably of the results. The former of these examiners says: "Both boys and girls are carefully and thoroughly instructed in the Holy Scriptures, Church Catechism, and Liturgy of our Church, and they have done justice to the instruction so received." In the boys' school, he was "much struck with the accuracy and rapidity with which the arithmetic, as far as Proportion and Practice, were performed." He congratulates the committee on the "efficient and satisfactory state of the school." The Rev. W. Taylor states that, "the first and second classes read steadily and carefully on Alston's system, showing that they did not read from memory, but made out the words as they occurred. The lesson on English history given by the schoolmistress was very satisfactory." The examiner of the boys' school, at Christmas last, reported favourably as to their proficiency in reading, religious knowledge, ciphering, embossed writing, English history, and geography; a small class also worked some problems in Euclid for him in very good style. The chaplain's classes, held on four days in the week for special religious instruction, comprise some not in daily attendance at the school, and exclude those who have not yet learned the Catechism.

The report states that "few of those who study music attain proficiency as readers or workers, and that great difficulty exists in procuring situations for blind organists. It is therefore most important that before making application for a pupil to receive musical instruction, his friends should well consider whether they have a fair chance for securing for that pupil employment as an organist or teacher of music. If a pupil becomes a good musician and is able to command employment, he may do well, but if from lack of talent, or other causes, he is unable to find employment as a musician, or to gain a living at a trade, he will probably become a burden to his friends."

During the year 1857, a novel and most important feature was introduced into the school, by the formation of a band of about forty instrumental performers, who are instructed in secular as well as sacred music. The band contains about an equal number of wind and stringed instruments, and during last year they gave a concert at the Hanover Square Rooms, which cleared upwards of 120*l.* for the charity, after all the heavy expenses were paid. The report states, "that though an attractive feature of the school, it is difficult to assign the band a higher office than that of supplying to the pupils a most pleasant and welcome recreation in their leisure hours."

One other feature in the operations of this school, derived from the example of a contemporary institution, demands especial notice from the writer of this article, with whom the idea originated, and by whom it has been carried out for many years at the institution with which he is connected, namely, an inquiry at certain intervals as to the after-life of the pupils. Such an inquiry can alone truly show the results of education; it is applicable to all schools, but more especially to those where children are boarded and educated for a series of years, and in whose future welfare, those who have directed their education, known their failings, and their better qualities, cannot but be interested. To all schools of poor-law unions it ought at once to be applied. The managers of the London School for the Blind, have sent out since the year 1854, about 150 forms of inquiry respecting pupils who have left school, and are now at work in the country. The inquiries embrace the following points: their present mode of gaining a livelihood; their average weekly earnings; their power of reading; their knowledge of music, and the use they make of it; and their moral character. The result of these inquiries is very satisfactory;

about ten only have not been answered; the pupils, with rare exceptions, possess good moral characters for steadiness, diligence, and Christian principle; for the most part these returns are attested by the minister of the parish. Most of them retain, to a greater or less degree, their power of reading, though many of them are greatly in want of books. Few are able, even with the utmost exertion to maintain themselves fully; but most of them are doing what they can, and only twelve receive parochial relief. Those able to do most towards their support are workers at baskets and mats, but the greatest difficulty prevails in finding employment for the musical pupils, many of whom having been educated for musicians, are unfitted for work of any other kind, and spend most of their time in idleness. The importance of the industrial work taught in the school is thus clearly established.

The Hospital and School for the Indigent Blind of Norwich was originally established in the year 1805, first for that city, and subsequently (as the condition of receiving a donation) for the county of Norfolk also; but its doors have been opened to other parts of the kingdom since the year 1819. The blind in the more elevated sphere of society appear not unfrequently to have been the first benefactors of their more indigent brethren. Mr. Tawell, a blind gentleman residing in Norwich, first called the attention of that city and its neighbourhood to the wants of the blind, and with a munificence commensurate with his zeal, he purchased "a large and commodious house, with an adjoining garden of three acres in extent," which he offered as the basis of the institution. The plan of the Norwich Asylum was to unite a school for the young with an hospital for the aged. It designed to admit the young pupils at the age of twelve years, and to keep them in the school till they should have attained a sufficient knowledge of some trade, as far as this could be accomplished within three years, but under no consideration to keep them longer than that time: some however have been kept longer. With respect to the aged, the rules express that none shall be admitted who have not attained the age of sixty-five years. It appears from the account of the institution published up to the end of 1833, that from the establishment of the institution to that date, 153 pupils had been admitted and 48 aged persons: 77 had been discharged qualified to work for themselves; 12 had proved incapable of instruction; 4 had left the asylum without leave, 13 had been discharged for irregularity, and 16 at their own request; 43 had died, and 36 remained on the books. The expenses seem to have averaged about 1100*l.* per annum, and the income about equalled the expenditure. (We can give no more recent account of the Norwich school, as no answer has been received to our inquiries.)

The Asylum for the Blind at Glasgow is pre-eminently a manufacturing establishment, although much attention is also given to the religious and secular education of its inmates. It was founded by John Leitch, Esq., of Glasgow, who was himself partially blind; he bequeathed 5000*l.* towards opening and maintaining the institution. Since the opening of the asylum in 1828 to the commencement of the present year (1859) 334 blind persons have been admitted; of this number 103 are now in the establishment. The manufactures carried on are of sacks and sacking, twine, baskets, mats, mattresses, and knitting. The sales in 1858 produced 5960*l.*, which was about 870*l.* less than the previous year, and the value of the manufactured materials on hand was 2024*l.* The revenue is chiefly derived from the sales, and in this respect the Glasgow asylum differs from every other in the kingdom. It solicits no annual subscriptions, but depends entirely for its support upon donations and legacies; this source is precarious, and sometimes, as during the past year, a deficit occurs. By the system pursued in this asylum the blind are placed, as nearly as circumstances allow, on a level with other workmen. Many of the adults reside with their families in the city, and go to their labour at the asylum like other artisans. The superintendent purchases the raw materials for the manufactures, and keeps an account of the work each person performs, from which a statement of their earnings is made, and they are paid every Saturday. The male adults are allowed the same rate that other workmen have for the same kinds of work; if a man can make five or six shillings a week, he receives that sum for his weekly wages. At the end of every four weeks a statement of his earnings is made up from the work-book, and whatever he has earned over that sum is paid to him, and also an additional shilling a week as a premium upon his industry. If the amount which he ought to earn be not earned, or the work be bad, no premium is allowed. At the monthly settlement some of them will have several shillings to receive in addition to their regular wages and premiums. Ever since the regulations regarding wages have been adopted, a marked improvement has taken place both in the quantity and quality of the work produced. The blind workmen and their families receive the fruits of their labour with much pleasure. A spirit of industry is excited and kept up very different to their former habits, and an opportunity is thus afforded them of enjoying the blessings of home, which could not be cultivated when they were maintained within the establishment. A few elderly females are placed upon the same system; they work in the institution, but reside at their own homes. Females generally, above the age of eighteen years, are admitted as day-workers; they dine at the asylum and receive regular weekly wages; their apartments are separated from those of the males, and no intercourse

is permitted. Boys and girls from ten to sixteen years of age reside in the house, and in addition to attendance on their classes, they are taught to perform light works suitable to their age, till old enough to be removed into the regular workshops. The girls and female adults are under the superintendence of a matron, who also has the mangement of the sales. Several of the blind men are employed in calling on the customers of the asylum to deliver goods and to solicit orders. It is common for adults who reside in distant parts of the city to go to and from their employment without a guide, and no accident has ever happened to any of them. The usual branches of learning are taught to the young blind in the Glasgow asylum; the time devoted to school by both boys and girls is five hours a day on five days of the week, the chaplain being their teacher. The books used are printed in the Roman alphabet, which was arranged under the superintendence of John Alston, Esq., the former treasurer of the asylum, these books are printed on the premises, and are so numerous as to form a library in raised type. [BLIND, ALPHABETS FOR THE.]

There are three Asylums for the Blind in Dublin. The oldest of them, Simpson's Hospital, was opened in 1781; it was founded and endowed by a merchant whose name it bears, who was himself subject to a disorder of the eyes, and was also a martyr to the gout. The design of the hospital is to provide an asylum for blind and gouty men, the preference being given to those of good moral character, who have formerly been in affluent circumstances. About fifty persons partake of the benefits of this charity. It was incorporated in 1799, and its income is about 3000*l.* per annum.

The Richmond National Institution for the Indigent Industrious Blind is supported by subscriptions and donations; it was opened in 1809; the inmates, who are all indigent, are instructed in the trades ordinarily taught to the blind. At present the institution contains forty men and youths, who are lodged, maintained, and clothed there.

The Molineux Asylum is supported by subscriptions, by the profits of a chapel, and by charity sermons; it is solely for the reception of females, who are admitted at all ages. Those above fifty have here a permanent abode. The younger section of the establishment are lodged, clothed, and fed; and for a certain number of years receive instruction in those employments by which it is intended they shall earn their living. This asylum was opened in 1815, in the mansion of Sir Charles Molineux, Bart. This family has been among its most liberal benefactors.

In 1835, the Ulster Institution for the Deaf and Dumb, established at Belfast in 1831, admitted blind pupils also. This union of the two classes is a specialty in which this establishment does not stand quite alone. Between the two classes of inmates there is nothing in common, so far as their education is concerned; different senses being addressed, the process of instruction is essentially different, but when a medium of intercourse has been established between them by means of the manual alphabet, their being associated together is not without some points of interest.

On subjects of instruction the first place is given to religious training, and as a result of this, some of the blind pupils have become devoted and efficient city missionaries; one of them occupies an important position as one of the ministers at Brooklyn, New York. The other common branches of an English education also receive attention, and all who have voice and ear practise vocal music. About six hours daily are devoted to school, and two and a-half hours to manual labour. A large amount of the instructions conveyed is given orally, but the relief books printed at Glasgow, and those produced at Bristol are used by the pupils. Ninety-one deaf and dumb, and thirteen blind, are now in this institution.

The Limerick Asylum for Blind Females was established in 1835, chiefly through the instrumentality of the Dean of Waterford. It is capable of accommodating twenty inmates, but the funds of the institution do not afford support to this number.

The Yorkshire School for the Blind was instituted at York in memory of the late William Wilberforce. Its design is not so much to provide maintenance for the blind as to give them such instruction as may help them to gain a livelihood for themselves, attention being at the same time paid to their moral and religious instruction; their friends or parishes therefore contribute towards their support while they are in the institution. Those persons only are admissible who have lost their sight to such a degree as to be able at most only to distinguish light from darkness—those who have a capacity for instruction—those who are free from any dangerous or communicable disease—and those who have no vicious habits.

It is found from the recent reports of the Yorkshire school that less time is devoted to manual labour than in these asylums generally; but it must be remembered that the inmates are young. Music is much cultivated, and affords satisfactory evidence of its utility. With the view of forming a correct opinion on this subject, inquiries were instituted in 1856, as to the condition of the pupils who had left school. It was found that eleven had obtained situations as organists, and were enabled to maintain themselves fully; four others were engaged in teaching music and tuning instruments, and thus maintained themselves to a great extent. In addition to those who had left school, there were six male adults and one female still resident in the school, who were filling organists' situations. The results of these inquiries as to other industrial pursuits were less satisfactory, and the inference drawn was, that

music was the only really remunerative pursuit for the blind, under the present arrangements of the Yorkshire School.

Another hint of considerable value may be drawn from the series of reports of the Yorkshire school. A year or two ago, a sergeant was engaged to drill the pupils, and it has been found of the most essential benefit to them. One of the pupils remarked, that he walked with much greater confidence since these exercises had been practised, and this feeling will be one of general experience; it may therefore be commended to the attention of other establishments for the blind. The superintendent of the Yorkshire school is W. D. Littledale, Esq., who is himself blind, and whose whole heart seems to be given to the improvement of the school. The general branches of education are taught, and books in the Roman type are preferred. The Rev. W. Taylor, author of the 'Tangible Euclid,' formerly devoted to the interests of this school, has left York; his attention, however, is still directed to the welfare of the blind. The number of pupils in the York school is sixty.

Henshaw's Blind Asylum, at Manchester, was opened for the admission of inmates in 1838. An endowment of 20,000*l.* was left in the year 1810 for the support of such an asylum, by the will of Thomas Henshaw, formerly of Oldham. Notwithstanding the large accumulations arising from this source, no part of Mr. Henshaw's bequest could be appropriated to the purchase of land for such asylum, nor for the erection of a suitable building; and the sum of 10,000*l.* was subscribed by the inhabitants of Manchester for these objects. The building, together with one in exact correspondence, for the education of the deaf and dumb, was erected at Old Trafford, and the approximation of the two charities was rendered closer by a subsequent agreement of the respective committees for the erection of a chapel in the space between the two buildings, thus connecting them as consistent parts of one uniform structure, in the English Academic style of architecture. The object of the asylum is not only to afford a home to the impotent and aged blind, but also "to maintain and afford such instruction to the indigent blind of both sexes capable of employment, as will enable them to provide, either wholly or in part, for their own subsistence, and to promote the employment of, or to employ, blind persons." The training of the inmates is therefore both intellectual and industrial, but it is not stated in the last report how the school instruction is carried on. It may be inferred that the books in Roman type are used; the late governor, Mr. Hughes, emphatically says, "I would discourage all systems of embossing which could not be read and taught by seeing persons." The articles manufactured are more various than in the generality of these asylums. The number of inmates in 1858 was seventy-five.

The Royal Victoria Asylum for the Blind, at Newcastle-upon-Tyne, was founded in the year 1838, to commemorate the coronation of Her Most Gracious Majesty the Queen; its object, as expressed in its first regulation, "being, to afford to the blind an elementary education, and instruction in those branches of trade and manufacture which shall be found suited to their capacity," as well as to afford them spiritual instruction. During the existence of the asylum, 115 pupils have been received into it, of whom 37 are now under its care, 22 of whom are males, and 15 females. Pupils are received into it from the four northern counties of England. The works of the inmates are of the usual kinds; the forenoon of each day is given to manual labour, the afternoon to music and general education. The relief books in Roman capitals are preferred.

The West of England Institution for the Blind was established at Exeter in 1839. It contains twenty-five inmates of the two sexes, all of whom are taught the usual branches of education, including music, and some to make baskets, mats, rugs, sash-line, &c. Sixty-two of its boarders and forty-one day pupils have quitted since its commencement. Its income is derived from the usual sources, namely, subscriptions, donations, board of pupils, and sale of work. Lucas's raised alphabet is used, and it is one of the regulations of the committee that "the system of teaching to read shall be that by means of the raised stenographic character."

An Institution for the Blind and Deaf and Dumb was formed at Bath about the year 1840. A considerable number of pupils of both these classes have been instructed under its care; and at the date of the last report (1858) it contained fifty-one boarders, of whom twenty-eight were deaf and dumb, twenty blind, and three partially blind and deaf and dumb; it also extends its benefits to day and sunday scholars, of whom it numbers twelve deaf and dumb, and four blind. Miss Elwin, of Bath, has taken a benevolent oversight of this establishment, from its first commencement to its present mature condition. A "Home" for blind girls has also been formed, for those who, having passed the allotted period of five years' instruction, have no friends able to provide them with a suitable place of residence. The training which the blind children receive is both intellectual and industrial; the former comprehends reading, on Lucas's system, arithmetic, geography, music, and singing; the latter is confined to basket-making. The morning hours are devoted to labour; the afternoon to mental and religious instruction. In the "Home," the greater part of the day is spent in basket-making, which contributes in part to the support of the establishment, and the inmates are frequently read to while they are at work.

An asylum for the young blind was established in Brighton in 1841,

the pupils not to be under six, nor exceeding twelve years of age. It is designed for the town of Brighton and the diocese of Chichester, with power to the committee to receive candidates from other localities. This school is under the management of Mr. Moon, one of the inventors of raised characters, to whose system attention has been directed in the article, BLIND, ALPHABETS FOR THE. The school contains twenty-one pupils.

The Midland Institution for the Blind is situated at Nottingham, and comprehends the counties of Nottingham, Derby, Leicester, Lincoln, and Rutland. Its chief object is the education and training of the younger part of the blind community. The age of the inmates varies from nine to twenty-four. The usual intellectual and religious instruction is imparted, and the trades are much the same as those followed in other establishments; it is thought some new trades might be profitably commenced, and, among others, brush-making. No male pupils are allowed to commence work till they can read; but the female pupils, from the day of their admission, spend half the day in their work-room, to be instructed by the governess in sewing and knitting, and the other half in school. The teachers, except the governess, are all blind. Lucas's system of raised type is generally adopted, but some of the pupils can read Moon's and the Roman books. The schoolmaster, who is blind, reads books on six different systems, but gives the preference to that of Lucas. In arithmetic the pupils are considerably advanced, and can work and comprehend fractions and decimals; the arithmetical board and pegs differs from that used in the institutions of Scotland. The admission of day-pupils *free* on the recommendation of a governor is a good feature in this establishment, though it is not confined to it. Such pupils may remain as long as there is room for them; and when they have acquired a trade, so as to make articles sufficiently well for sale, they are employed and paid journeyman's wages.

The General Institution for the Blind, at Edgbaston, near Birmingham, was commenced in 1846 by private benevolence, and adopted by the public the following year. Its income is derived from the usual sources, namely, subscriptions, legacies, donations, payments on behalf of pupils, sale of work, &c. The present number of pupils is fifty-nine, and they are classified both for school and labour, so as to give all the advantages suitable for their age. The school teaching comprehends reading, spelling, arithmetic (peg and mental), geography with the aid of globes and maps, and object lessons. There are upwards of sixty maps, and one is used by every two pupils. These maps are made by friends of the superintendent, and have been much admired by the conductors of different institutions. In music the pupils practise from one to three hours a day, according to their progress and talent. Church music only is taught. Four of the pupils, from sixteen to eighteen years of age, have obtained situations as organists, at salaries varying from 20*l.* to 30*l.* a year. In reading by the touch, Moon's system is used. This institution has the advantage of an indefatigable treasurer, Thomas Goodman, Esq., whose exertions for this and other charities which have for their object the relief of human suffering, are beyond all praise.

The title of the next institution to be noticed would lead to the supposition that a new sphere of operations was to be brought under observation. It is called "The London Society for Teaching the Blind to Read." It is situated in Avenue Street, Regent's Park, and it has been in existence twenty years. The indications of its distinctiveness are few, and chiefly relate to its plan of admitting pupils, and its adhesion to Lucas's system of reading, in which it has published the whole of the Scriptures and many other works. The usual kinds of school-instruction and of labour are taught to the pupils, of whom there were sixty in the institution in 1858. As an auxiliary in the cause of the blind, it must prove beneficial. According to its rules, it receives free boarders on the nomination of donors of 250*l.* in one sum, and by election of subscribers for three years; indigent boarders on payment of 15*l.* per annum; music being an extra charge of two guineas per annum. Male adults are not lodged in the house, and have to pay 2*s.* a week for lodgings in the neighbourhood. Day-pupils are admitted free on the recommendation of a subscriber.

The establishments of which some account has been given are not the only means carried on in these days for alleviating the condition of the blind, and increasing their means of happiness. Other appliances are also in action. Although blindness cannot be considered as the heaviest of human calamities, it is one which claims the most immediate sympathy and prompts the universal desire for its relief. Societies have been established for teaching the adult blind to read; many of which are connected with Moon's system. Mr. Moon, himself blind, commenced his printing labours at Brighton more than ten years ago; his books are not only largely used in that place, but in many other provincial towns, which have been supplied with home teachers, and in which lending libraries have been established. One of these societies has been formed in London; from it have emanated two lending libraries of Moon's books; and its first report (1857) states that in eighteen months 236 blind pupils had, for longer or shorter periods, been under instruction; of these 117 had learned to read, of which number 53 were above 50 years of age, and 8 were from 70 to 75. It would be very ungracious to cast a shade of doubt on the statements put forth of the rapidity with which the art of reading was acquired by these aged persons through the medium of touch; yet

there must be some fallacy, the facilities given by a previous knowledge of reading and spelling must have existed, for even aged persons with all their senses cannot learn to read *in three lessons!* If they could read and spell before they lost their sight, or if they had learned to read on some other system previously, the wonder ceases to some extent. The work is a good work, and requires nothing marvellous to sustain it. The London depository for the books on Moon's system is at 25, King William Street, Trafalgar Square.

In Euston Road, near St. Pancras Church, a thoroughly practical work is going forward for the amelioration of the condition of the industrious blind. It is known as "The Association for promoting the General Welfare" of this class of people. It has been in operation about five years; it provides means of industrial employment for those who have not been so fortunate as to obtain admission, and consequently instruction, in asylums; it supplements the education of those who have had this advantage; it teaches trades to those who have learned none, and finds a market for the work, thus enabling many of the adults so taught to support their families; it supplies regular work to many at their own homes; it finds workshops for others within the precincts of its own humble establishment. At present it affords employment to sixty-seven blind men and women, some of whom have been withdrawn from begging and destitution, and it has a list of upwards of ninety candidates, who desire to be put into a similar mode of earning their bread, and who will be gratified in their desire when the public favour to the establishment demands more articles than the present workers can supply. The town traveller and the porter of the establishment are both blind, yet they traverse crowded thoroughfares, and walk long distances, self-dependent, or trusting on the good-will of strangers for information and direction. Blind agents are also employed in selling the goods manufactured in several towns in different parts of the kingdom. This society is assisted by subscriptions and donations, for from the waste of materials and the slowness of the learners it cannot be self-supporting. The foundress of this truly beneficent association is Miss Gilbert, a daughter of the bishop of Chichester, herself blind, and a contributer of 2000*l.* to its endowment fund; for more than a year she worked the plan alone. Its control is now made over to a committee of influential men, and it may be hoped that the practical wisdom which devised its plans will be carried out with that ability which will ensure success commensurate with its object. The above account of this excellent charity is abridged from an article in 'Household Words.'

Charities for the blind also exist which grant annuities under certain conditions. The oldest of these is Hetherington's, it was established in 1774; the other is the Blind Man's Friend, established by Mr. Day; in October 1858 there were 2500 applicants waiting for this charity.

It appears that voluntary benevolence, together with the provision made under the Poor Law Act, by which the blind may be maintained during education in the asylums established, will in the course of time provide for the training in industrial pursuits of all the blind who require such aid. Great has been the progress towards this end during the last twenty-five years. The intellectual training will doubtless keep pace with the industrial, now that the public are aware how much can be done. The increase of books is also certain, with so many competitors for public favour in the field. It has been already stated that the Scriptures are published in four distinct systems. Attention should now be directed to the publication of a good reading-book on secular knowledge, the subjects of which should be consecutive, progressive, and systematic. The republication of some existing school-book is more desirable than the preparation of an original work for many reasons; but it should not be a miscellaneous collection of lessons without plan or arrangement on every variety of topic in succession, tending to bewilder and excite rather than to satisfy the mind. The moral tone of the inmates of the various schools is a subject of special mention in many of the accounts we have received, yet it is thought some advantages would arise from a stricter classification, so as to prevent the young blind from mingling with the adults and the aged. In the workshop the restraint which is necessary for the young is irksome to the older inmates, and the exercise of all their good principles is requisite to prevent the rising of a rebellious spirit. Separate establishments for children and adults, or an entire separation in the same building seems desirable. At Norwich there is such a provision. The inmates of Henshaw's asylum, at Manchester, are not restricted as to age, and are in for life, but the old are not separated from the young, consequently they cannot have that quietude which age and infirmity require. In one or two of the establishments drill and gymnastics receive attention. These physical exercises are highly commended by Dr. Blacklock, as giving confidence, and they should be universally cultivated among the young blind. It is a question worthy of some consideration by the managers of our asylums, as to what extent blind teachers can be eligibly employed in the various departments. As far as the communication and transmission of ideas are concerned, the blind teacher may possess some advantages over the seeing one, yet circumstances arise in which the evils attendant on the want of sight counterbalance these advantages. In the *school-room* we find bad habits and positions of the body; in the *workshop*, badly shaped articles and waste of materials; in the *musical department*, wrong positions of the hands, and a bad system of fingering, with

an awkward attitude and distortion of the countenance in singing. It cannot be expected that blind teachers should be aware of these things. An exact record of the after-life of all the pupils should be kept in every asylum for the blind. Such records are the result of the care and attention of teachers, and of the application and attainments of pupils, and the blind themselves should know that such an account of their future course will be recorded, and published for the satisfaction of those who generously support these establishments for their benefit.

The number of blind men who have become eminent is large; for some account of them we must refer to the work of Dr. Guillié on the 'Instruction of the Blind,' to blind James Wilson's 'Biography of the Blind,' to the first volume of the 'Pursuit of Knowledge under Difficulties;' and to Dr. Kitto's 'Lost Senses—Blindness;' in these works we read of philosophers, mathematicians, divines, musicians, rhetoricians, lawyers, historians, poets, naturalists, road surveyors, mechanics, travellers, and even sculptors, who laboured under the infirmity of blindness.

The addition of deafness to blindness seems almost to shut out a human being from the external world. It is difficult to conceive how the mind of a deaf, dumb, and blind person can be occupied—much more difficult to say how it can be improved and educated. Yet there are many cases of this three-fold deprivation known, and there are always one or more such instances undergoing instruction in our blind or deaf and dumb institutions. The case of *James Mitchell*, the son of a Scotch clergyman, which was investigated by Dugald Stewart, Mr. Wardrop, and Dr. Spurzheim, is the best known; *Julia Brace*, a pupil in the asylum for the deaf and dumb at Hartford, Connecticut, is another instance of the same kind; *Victorine Morisseau*, a pupil in the Imperial Institution for the deaf and dumb of Paris, was another sufferer under this accumulated calamity; *Laura Bridgeman*, a pupil of Dr. Howe, in the Boston Asylum for the blind, is not only defective in these senses, but also in that of smell. She has had companions in the same affliction in *Oliver Caswell* and *Lucy Reed*. *Edward Meystre*, of Lausanne, is another case of the kind. He too has met with an instructor. Each of these instances is a history in itself of a mind sealed up, but unsealed by the indefatigable zeal and skill of their respective teachers. Space is not allowed us to go into the manifold processes which patience and enterprise invented for conquering the difficulties which interposed between these minds and the world without. The results are not merely satisfactory, they are marvellous.

The blind are not a moody or a discontented class—fun, frolic, and mischief are as inherent in them as in others. We extract a few anecdotes from an interesting pamphlet published some years back by Mr. Anderson, who passed many years of his life as teacher and superintendent in the several asylums of Edinburgh, York, and Manchester, which show their vivacious habits.

"Romping, jumping, laughing, and screaming, are as delightful to them as with boys and girls who see. The cross-bow, bow and arrow, trundling each other in a wheelbarrow, spinning tops, and to those who have a glimmer of light, called 'blinkers,' marbles, and a kind of cricket, all afford ample amusement, while there is no want of the usual boyish plotting and mischief. The girls also enjoy their play-hours very much, and contrive to stand in as much need of the needle as their more favoured sisters of sight.

"A girl at York took up a book lying beside me, turned up her face towards the gaslight above my head, and playfully observed, as she whirled over the leaves, 'Dear me, sir, what bad gas this is, I can't see to read a word by it!' The same girl standing near the fire, heard a companion trying to decipher some of the letters of the book in relief, 'Let me see,' said the latter, 'what's this—b i t, t e r; bit—what does that mean?' 'Sit a little nearer the light, my dear,' said her fireside companion, 'I know you don't see very well, Jane.' The tone of this indicated genuine playful mischief.

"A young man at the Edinburgh asylum, born blind, was at all times the essence of cheerfulness. He was one of our most correct 'messengers,' and a good collector of accounts, of which from the amount of our annual sales, we had many. He, as well as several others, could easily take from four to eight of these at a time. Coming along the passage whistling—he was always whistling—he began to grope about for his hat, which, not finding on its usual peg, he cried to a companion, whose foot he heard not far off, 'Willie, come here, man, and look for my hat, ye see better than me.' The one was as blind as the other.

"It is a remarkable fact that the blind scarcely ever hurt themselves, either against furniture, or in play. At Edinburgh they were constantly walking about the crowded streets. There were four or five 'messengers,' whose business it was to carry home all the goods sold—baskets, mattresses, rope-mats; and not only did they do this with the greatest exactness, but they were daily in the habit of going to all parts of the city, Leith, Portobello, and environs, to take measurements for bedding. I have many times had the dimensions of two, and even three beds brought to me—all on memory—with a precision not exceeded by the most expert workman, including the exact allowance of so many inches to be cut out for the bed-posts.

"I had occasion one evening, at Edinburgh, to send out one of these blind men with a mattress. I gave him the bill with it, that he might

receive payment. He returned with the account and the mattress too. 'I've brought baith back, ye see, sir,' said he. 'How so?' 'Indeed, sir, I didna like t'leave't yonder, else I'm sure we wad ne'er see the siller—there's no a stick of furnitur' within the door!' 'How do you come to know that?' 'Oh, sir, twa taps on the floor wi' my stick soon tell't me that!' Having to send the same man to Portobello, toward evening, I warned him (rather inadvertently!) that if he did not make haste it would get dark. 'My word, sir,' said he laughing, 'I wish I had a shillin' for ilka time I've been in Portobello i' the dark.'

"As a body, the blind are the most habitually cheerful of mankind. How it comes to be so I cannot tell, and I have no wish to theorise. I cannot designate the blind, as is almost universally done, 'the unhappy,' 'melancholy,' 'pitiable,' and so on. I know nothing more erroneous, or more opposed to the feelings of by far the greater majority." So says Mr. Anderson in his 'Observations on the Employment, Education, and Habits of the Blind,' and he was a man of large experience among them.

BLINDAGE (called also BLIND), is a term employed in military art to any temporary construction made to secure artillery against the effects of ricochet and vertical fire, or the troops against the effects of shells; it consists usually of stout timbers, covered with fascines, earth, and sodwork, and in fact is the temporary expedient for casemates.

In fortresses, when regular casemates have not been constructed for the protection of the ammunition and provisions, or of the soldiers while not employed in active duty, covered buildings of a temporary nature are formed for those purposes at, or previously to, the commencement of a siege. The simplest are such as are made against the side of some strong wall within the place, or, which is preferable, against the revetment of the counterscarp, in a dry ditch, on any of the fronts not exposed to the fire of the enemy. These inclined blindages consist, when timber is plentiful, of thick beams placed close together, and leaning against the wall at an angle of 45°, one extremity of each resting on a sleeper laid in the ground: in other cases the beams are placed at intervals from each other; over them are laid horizontal joists close together, and the whole is covered to the required thickness with fascines and sods when they can be procured; the entrance is at one extremity of the building. This kind of blindage is also constructed to cover the miner employed in piercing the escarp wall of a rampart when the breach is to be formed in it by the explosion of a mine.

A blindage is sometimes formed independently of any wall, by planting the timbers in the ground in inclined positions so that their upper extremities meet together in a ridge, when the building resembles the roof of a house, and the whole is covered with fascines and sods. But generally an area is enclosed by a wall made of strong palisades planted vertically in the ground, the roof being formed of timbers disposed horizontally and close together, above which comes the bed of fascines and earth. For a small magazine the inclosing wall may consist merely of gabions filled with earth; the area being covered as before.

A blindage is said to be bomb-proof, when, from the thickness of its roof, it is capable of resisting the shock of loaded shells; and splinter proof when merely capable of securing persons within it against the fragments resulting from the explosion of such shells.

The French give the name of blindage to any building already existing in a fortress, when a shell-proof covering has been made to it in place of its proper roof; this cover is obtained by placing girders over the interior, and overlaying them with joists and earth. And when the walls are not sufficiently strong they should be cut down to a convenient height, and covered as before. On the exterior of the building leaning blindages may be formed as above described, and sometimes the whole of the exterior walls are protected in the same manner, leaving only the entrances, which are generally opposite to the piers between the doors and windows, where some of the inclined timbers are omitted: but occasionally the walls and roof are merely strengthened and supported by shoars or inclined props firmly fixed below in the ground, and above resting against and supporting the extremities of the girders. For these kind of blindages such buildings should be selected as have their lengths in the probable direction of the enemy's fire, to avoid as much as possible their being exposed to direct fire.

To secure some of the artillery on the ramparts of a fortress against the effects of ricochet and vertical fire, shell-proof blindages are formed, by planting in the earth strong palisades vertically six feet on each side of the gun, extending from the interior slope of the parapet about 24 feet to the rear, across the terreplein or upper surface of the rampart; these carry a roof made with timbers, which extending forwards covers the embrasure as far as 9 or 10 feet from its neck, or interior extremity. These blindages are open towards the rear, and the guns fire through the embrasures as usual. The under side of the timbers of the roof is about 7 feet above the terreplein, and is covered with a double layer of fascines and earth above that to a thickness of about 5 feet. It has also been recommended to form the blindage in the thickness of the parapet itself, the roof being well covered with timbers, fascines, and earth, open to the rear, but the exterior closed by a number of stout timbers placed horizontally, so as to make a wall 4 feet thick, through which the embrasures are cut, like the portholes of a ship.

In the attack of fortresses, when the trenches of the besiegers become subject to a plunging fire from the place, they are protected by blindages; these are formed by fixing rectangular frames of timber, commonly called great gallery frames [MINES], vertically along the two sides of the trench, and placing similar frames or any timbers across the trench on the top of these, to carry the roof which consists of fascines covered with earth or raw hides.

Blinded trenches of this kind were formerly much used by the besiegers to protect their descent into the ditches of fortified towns; one of this kind was executed by the French for that purpose when they besieged Danzig in 1813.

BLINDNESS. [EYE.]

BLISTER, a term used to express a bladder or vesicle raised upon the skin by the application of some external irritating substance, and also to denote the external application itself by which this effect is produced. The terms *vesicatory* and *epispastics* are also frequently given to the external application or other preparation. The substance usually employed as a vesicatory is the powder of the Spanish fly. [CANTHARIDES.] The powder of the cantharides is mixed with lard and wax, so as to produce a plaster of tolerably firm consistence, which is spread on leather and applied to the part for the space generally of from ten to twelve hours. The first effect of the application of the blister-plaster to the external skin is to produce a sense of tingling and heat; this is followed by redness, commonly attended with pain, and subsequently there takes place an elevation of the cuticle into a vesicle or bladder, which contains a fluid resembling the serum of the blood. On the effusion of this fluid the redness continues for some time; the serum gradually thickens, and at last is changed into a whitish curdly substance, under which new cuticle is formed, though occasionally the serum is converted into proper purulent matter, the blistered part successively contracting, until the whole wound is healed. Sometimes coagulable lymph is effused.

The effect of the application of a blister is the production of a true inflammation over the whole surface of the skin with which the plaster is in contact. The effusion of a serous fluid from the excited capillary vessels of the skin is one of the ordinary phenomena of inflammation. The formation of the bladder or vesicle is occasioned simply by the elevation of the cuticle from the true skin, by the fluid poured out from the cutaneous capillary vessels. The inflammation induced by the blister is the effect of a powerful stimulus applied to the cutaneous blood-vessels and nerves.

The extent of the inflammation is usually confined to the surface in actual contact with the blister; it is comparatively rare that any degree of irritation is communicated to the general system; and yet the relief afforded is often so great, that the effect appears disproportioned to the cause, a small external inflammation mitigating or removing an extensive and severe internal inflammation. Much discussion has taken place as to the principle on which this relief is afforded, and the real mode in which the blister produces the benefit observed to result from it is not clearly understood. It is certain that the chief benefit results in the state of what is termed local inflammation; that is, when the inflammatory action is confined to a single organ or to a part of an organ. In order to understand the true nature of the change effected in the part relieved, it is obviously necessary to understand the true nature of inflammation. [INFLAMMATION.] It may be here stated, that in inflammation artificially induced with a view of observing the phenomena that take place in this process, the blood-vessels of the part inflamed are seen to enlarge and to become preternaturally distended with blood, while the motion of the blood in such vessels is either very much retarded or ceases altogether. The knowledge of this fact enables us to understand, in some measure, the action of a blister. The application of a powerful stimulus, such as that caused by the Spanish fly, in the neighbourhood of vessels relaxed and over-distended with blood, relieves such vessels by depriving them of a portion of their blood, and by consequently removing the state of over-distention. For the stimulus applied to the skin determines a large quantity of blood to the cutaneous vessels under the influence of the vesicatory; this blood is derived from the blood-vessels of the parts in the immediate neighbourhood of the vesicated skin, from the blood-vessels of the inflamed part among the rest; and the blood-vessels of the inflamed part being relieved from the preternatural quantity of blood that distended them, return to their healthy action.

Another reason has also been assigned for the relief afforded by the application of blisters. It is observed, that when a morbid action exists in any part of the body, it may sometimes be removed by exciting a morbid action of a different kind in the same or in a neighbouring part. It is assumed that two morbid actions of different kinds cannot go on in the same part at the same time; hence the surgeon and physician, when they observe diseased action going on in a particular part of the body, induce, as near to that part as possible, another action of a different kind, frequently with the effect of lessening or altogether stopping the former morbid action. Now one of the instruments most commonly employed to excite this new action is the blister, and the excitement of such action, on the principle just stated, is conceived to be one mode in which the blister, as a general remedy, proves beneficial.

But whatever be their mode of operation, the fact is certain that blisters often prove more extensively beneficial than could have been anticipated from the limited surface on which they act, and from the very slight discharge they induce. Though, as already stated, they are most beneficial when the inflammation is seated in a particular organ or in part of an organ, yet they are by no means without advantage in cases in which the system is generally and deeply involved; but then benefit can only be obtained from them after bleeding, purging, and other evacuants have lessened or subdued the general action of the system. In this case they often complete and render permanent the benefit derived from the preceding remedies.

For the reason already assigned, they are most commonly employed (after remedies that act powerfully on the general system) in pneumonia (inflammation of the lung), in gastritis (inflammation of the stomach), in hepatitis (inflammation of the liver), in phrenitis (inflammation of the brain), and so on; but there are diseases of the nervous system in which they are decidedly useful, as in spasmodic affections attended with pain but without inflammation, in the paroxysms of angina pectoris and of spasmodic asthma, in epilepsy, catalepsy, hysteria, paralysis, &c.

Benefit is sometimes derived from the application of blisters through their immediate and direct action as stimulants, chiefly in full habits, in which languor is the consequence of over-distension. In these cases they excite the whole system, and produce an exhilarating effect. A gentleman once highly distinguished at the bar, and of brilliant convivial powers, always applied a blister when he wished to shine in either sphere, and the effect was produced as soon as the warmth in the part began. Many persons, even though they feel acutely the pain produced by blisters, declare that the relief from the previous languor counterbalances all their sufferings.

The application of a blister is sometimes successfully employed as a means of directly lessening pain. The excitement of one pain diminishes another: hence the relief afforded in tooth-ache and other painful affections. Although in general blisters relieve more pain than they give, yet in some irritable skins and in some irritable states of the system they produce occasionally extreme excitement and suffering. By the previous employment of the appropriate remedies for soothing the irritable state of the system, the beneficial effect of blisters may be obtained even in constitutions thus predisposed to irritation from the operation of this remedy, which constantly produces good or bad effects, just as its application is well or ill timed. One painful affection occasionally induced (strangury) is effectually relieved by an anodyne injection thrown into the rectum, consisting of four or six ounces of thin tepid gruel, with thirty or forty drops of laudanum.

BLOCK (German, *Blöcke;* Dutch, *Blokken;* Swedish, *Skepps-block;* French, *Poulie;* Italian, *Bozelli;* Spanish, *Motones;* Portuguese, *Moutões;* Russ, *Bloki*), an instrument generally made of wood, but sometimes of iron. It is much employed in the rigging of ships to give facility to the raising or lowering of the masts, yards, and sails, and for such other purposes as require and admit of the application of the pulley—a block, as used on board of ships, being simply a pulley in the greater part of its modifications. One description of blocks, to which the name of dead-eyes has been given, is not a pulley, being unprovided with sheaves. These dead-eyes are used for setting up and fastening the shrouds and other standing rigging of the ship, while sheaved blocks are used for the running rigging. The more usual form of blocks of both descriptions is that of an oval spheroid, flattened at opposite sides. Dead-eyes are made out of one piece of wood, pierced with the requisite number of holes, through which the standing rigging is passed. Single-sheaved blocks are made up of three distinct parts, namely, the shell, the sheave, and the pin which serves as an axis round which the sheave revolves. Some blocks are made with two, and others with three, and even four sheaves, which all revolve on the same pin or axis, and consequently parallel to each other, in separate chambers formed for that purpose in the shell of the block. Blocks in all their varieties are used also for the purpose of raising weights in every department of mechanics and constructive operations.

The construction of blocks would seem to be a very simple operation, such as any man accustomed to work in wood could perform with facility and accuracy; but this in practice is not found to be the case, as the parts must be fashioned and fitted together with the greatest possible accuracy, in order to insure their easy working when put together—a circumstance of considerable importance in the management of a ship. For this reason, block-making has long formed a substantive branch of manufacture, and is carried on either by itself, or in conjunction only with mast-making.

About 1801, Mr. Brunel succeeded in completing a perfect working model for constructing both the shells and sheaves of blocks. This model being submitted to the inspection of the Lords of the Admiralty, the invention was at once adopted by government, and Mr. Brunel was engaged to superintend the construction of the requisite machinery at Portsmouth, upon a scale sufficiently large for making blocks to supply the whole naval service of the country. The completion of this machinery occupied nearly six years, and was not brought into full operation until September, 1808; but similar machines are now in use at Chatham and elsewhere.

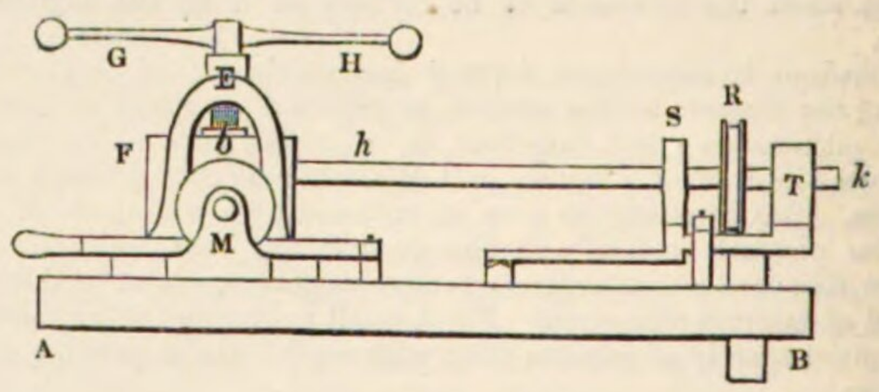
The assemblage of machines devised by his inventive genius for the formation of the blocks employed in raising burdens, and particularly in the important service of moving the rigging of ships, contains so many ingenious processes for gaining the proposed ends with the utmost accuracy, and, at the same time, with the least possible labour, as to justify the opinion that it constitutes one of the noblest triumphs of mechanical skill; and, in this article, it is intended to give a brief description of the principal parts of which it is composed.

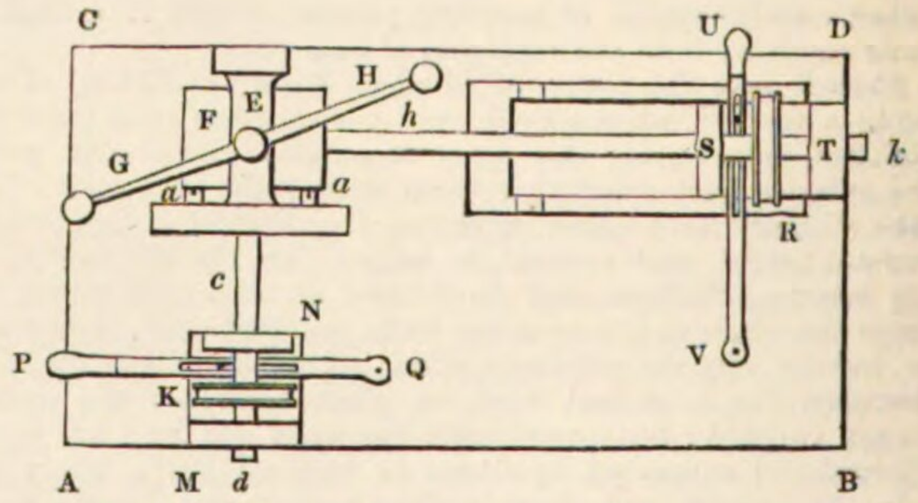
The machines may be said to consist of many saws and lathes; by these the work is performed, from the operation of cutting up a log of timber, to that of polishing the pins on which the pulleys turn; and motion is communicated to all of them by a single steam-engine.

A straight saw worked backwards and forwards, horizontally by the engine, cuts off in succession different portions transversely from the log of timber (elm) which, for this purpose, is made to rest on a table or low bench; the portions cut off being of the proper lengths for the dimensions of the intended blocks. For the smaller logs a circular saw is used; it cuts the tree transversely, and consequently its plane is perpendicular to the axis of the latter: the saw is capable of being raised vertically, or moved horizontally at pleasure, in order that it may be made to enter the wood above or below, or on either side.

After the log has been cut in slices, the latter are brought to what is called the ripping saw: this is circular; and its plane standing vertically, in part above the level of the table, it serves to cut the slices into rectangular parallelopipeds. In this state the wood is brought to the boring machine, which may be thus described (the lower figure representing the plan, and the upper a side elevation):—

The rectangle A B C D represents the surface of a strong table, on which is fixed an iron frame E having three legs; within these the parallelopiped F is placed between three screw-heads, two of which appear at *a a*, and it is rendered immoveable during the operation by means of the screw *b*; this last being turned by the iron bar G H. *c d* is one of the borers, which turns on its axis by means of the pulley K, the latter receiving motion from the engine: this borer rests on the frame M N, which is capable of being moved towards the frame E by pressing on the end P of the lever P Q, so as to turn it about the pivot Q. *h k* is another borer, which turns on its axis by means of the pulley R, the latter also receiving motion from the engine: this borer rests on the frame S T, which is capable of being moved towards the frame E by pressing on the handle U V, so as to turn it about the pivot V.



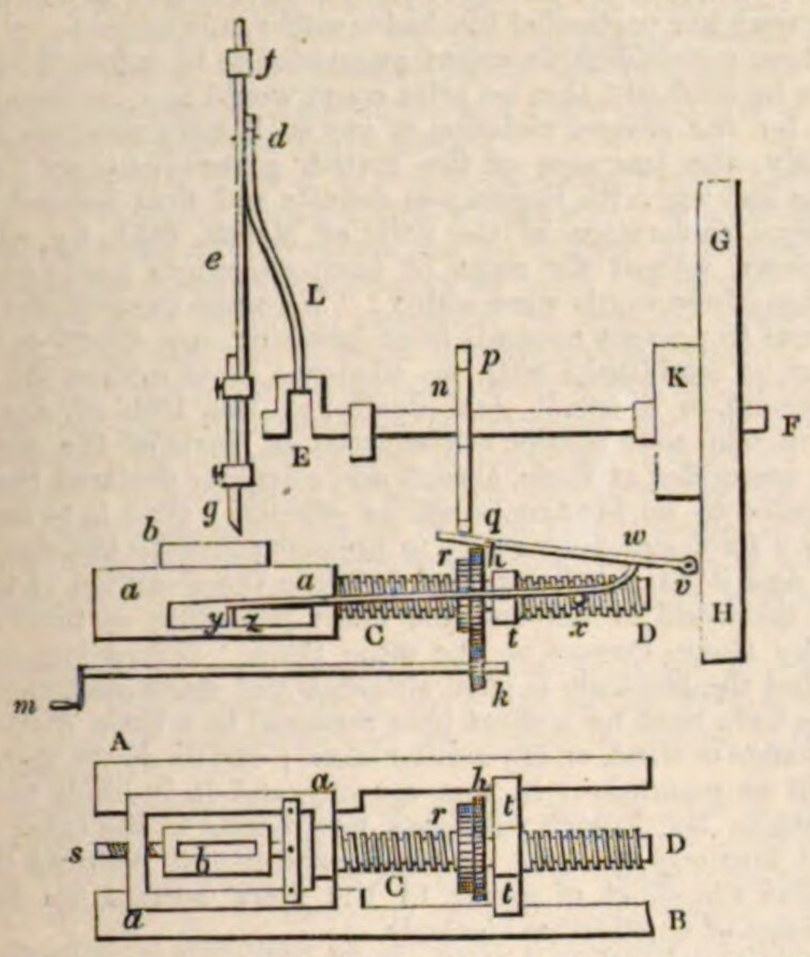


The former borer makes the hole for the pin on which the sheaves of the block are to turn; the other merely makes a perforation at a spot which is to form one extremity of the mortise intended to contain a sheave. If the block is to contain two or three sheaves, the borer is to make as many perforations, the frame S T being capable of moving in a direction parallel to B D, in order that the point of the borer may be placed where the required perforations are to be made.

A remarkably ingenious machine is employed to cut the mortises in which the pulleys are to turn; and it is hoped that the following cut and description will suffice to render the process intelligible. A B is a representation of the horizontal surface of the table or stage on which the block is placed; and the diagram above it exhibits a side elevation of the acting part of the machine, the pillars and braces which support it being omitted, as they would have concealed, in part, the apparatus. *a a* is a frame made to contain the block *b* which, in the diagram, has but one mortise; the block is tightly fitted in this frame by means of the screw *s* at one extremity, and the frame is capable of being moved along the stage from *s* towards *t t*, as much as the whole length of the intended mortise. The great screw C D is fixed at one extremity to

the frame which contains the block, and works in a concave screw, which is cut in the transverse piece *t t*, the latter being fixed to the table or stage.

E F is an axle which terminates with a crank at E and carries at the



opposite extremity the fly-wheel G H, the revolving motion being communicated from the engine by a strap passing over the cylinder K. The circular motion of the crank at E produces by means of the bent rod L, which turns on a joint at *d*, a reciprocating motion vertically in the rod *e* which passes through a collar at *f*: to the lower part of this rod is made fast the steel chisel *g* by which the mortise is to be cut; and it may be easily understood that, if two or three mortises are to be cut at the same time, as many chisels may be fixed, in line, parallel to one another, in a frame which is carried by the rod *e*. On the screw C D is a toothed wheel *h*, and below it is a small wheel *k* which can be turned round by means of the handle at *m*, and thus a small motion may be given to the frame *a a* in order to bring the hole previously bored in the block vertically under the chisel *g*. The axle E F carries an eccentric wheel *n* (seen edgeways), on the circumference of which rides one extremity *p* of a bent lever *p q*, the lower branch of which lies tangentially on the top of a ratchet wheel *r*: the inferior surface of this branch has a notch, the sides of which, by the movement of the eccentric wheel, are made to act on a tooth of the wheel *r*; and thus, the axle C D being turned, the frame *a a* is moved a little way towards the cross-piece *t t*. This movement always follows immediately after the chisel has made a descent, and thus there is presented a new part to be cut out from the block. Since the chisel goes quite through the block at each descent, and the movement is very rapid, the mortise is quickly made.

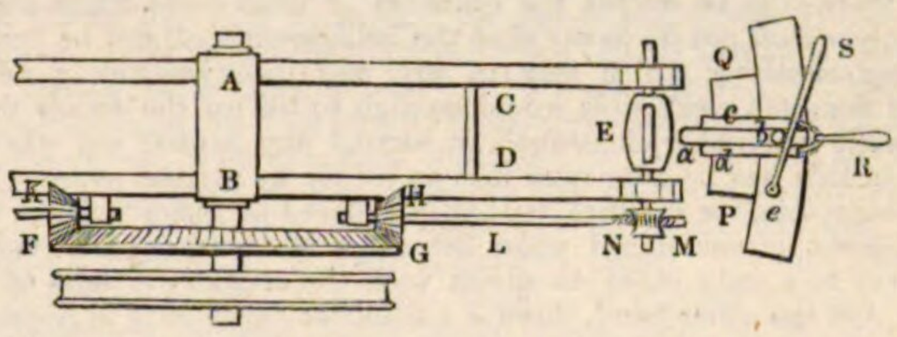
The extremity *q* of the bent lever *p q* rests upon a lever whose fulcrum is at *v*, and this rests at *w* on the bent lever *w x y*, whose fulcrum is at *x*, and when by the motion of the frame *a a* the notch at *y* falls over the extremity *z* of a projection on the side of the frame, the notch in the branch *q* is lifted above the top of the wheel *r*, and the mortise being completed, the frame with the block moves no further. The cylinder K is hollow, and within it, upon the axle E F, is a cone which, while it turns with the axle, is capable of being moved backwards or forwards on the latter by means of a lever not shown in the cut: when this cone is thrust as far as it can go into K, the friction is great enough to allow the axle to be turned with the fly-wheel and cylinder; but, on drawing the cone towards E, its surface is disengaged from the interior surface of K, so that the axle E F no longer moves with the fly-wheel. It is while the axle ceases to revolve that the mortise block is removed, and one on which the operation is to be performed is put in its place.

The block is subsequently submitted to the action of a circular saw, by which the corners are cut off, and it is made to assume the form of an octangular prism; in this state it is removed to what is called the shaping machine, in order to be reduced to the requisite figure.

The shaping machine consists of two wheels connected together and turning on the same horizontal axle; they carry between the interior surfaces of their rims ten blocks at equal distances from one another on the circumference; and at first the blocks are disposed so that the mortises in each are perpendicular to a plane passing through the common axis of the two wheels, the axes of the blocks remaining always parallel to that axis. The wheels are made to revolve by a strap passing over a cylinder on the axle; the cylinder being in connection with the steam-engine: the cutting tool is applied, on a level with the axis of the wheels, to a horizontal frame which has the form of a circular arc, the centre being in the middle of that axle; and while the edge of the tool is pressed against the block it is slowly

moved along the arc. Thus, the tool acting against the block during the revolution of the latter with the wheel, and being itself in motion horizontally, the face of the block is brought to the form of a segment of a sphere. Each block is then turned on its particular axis: first one quarter round, then another quarter, and finally a third quarter round: and in each of these positions an edge or side of the block is, by the tool, brought to a form similar to that which was given to the first face; the last of the four sides being completed after each block has been turned three quarters round on its own axis. The ten blocks are then removed and ten others put in their places, to be shaped in like manner.

The blocks are not turned on their several axes by hand, the machine containing an ingenious contrivance by which such revolutions are effected. In the following cut, A B is the axle of the double wheel, of which A C, B D represent two of the radii, and E one of the blocks at the circumference. A bevilled wheel F G is fitted on the axle of the double wheel, and, in the teeth of this, work as many pinions, H, K, &c., as there are blocks; each pinion has an axle L M in the direction of a radius of the great wheel, and extending as far as the circumference of the latter; near the extremity M is cut what is called a perpetual screw, whose threads work in the grooves of a pulley-shaped wheel N, on the axle of which is the block E.



During the process of shaping the blocks, the wheel F G revolves with the great wheel, carrying with it the pinions H K, &c., and their axles L M, &c., the pinions not changing their places on the circumference of F G, and consequently the blocks having no movements on their particular axles. But when the first faces of the ten blocks have been shaped, the whole machine is detached from the engine, and the wheel F G, which is capable of turning freely on the axle of the great wheel, being held fast, the latter is turned round by hand; this causes the pinions H K, &c. to move on the circumference of F G, and, at the same time to revolve on their own axes; thus the axles L M, &c. revolve, and, on account of their connection at N, &c., with the axles of the blocks, the latter revolve also on their axes. The numbers of the teeth are so proportioned that four revolutions of the great wheel, while F G is held fast, will cause each block to turn a quarter round on its own axle: this brings a new side of each block to the circumference of the wheel, and the whole machine being then re-connected with the steam-engine, the process with the tool is again carried on till the new side of the block is shaped; the machine is then released from the engine, the blocks turned as before another quarter round, and so on.

The part *a b* represents the shaping tool, which slides between the two plates *c* and *d* of a frame which is made to slide upon the circular arc P Q towards either of its extremities by moving the handle R; and while the tool is thus made to move slowly on the arc, it is kept close to the block by pressing on the handle S, which turns on a pivot at *e*, against a pin at *b*.

Lastly, the blocks are taken to what is called the scoring-machine, by which there are cut on each of the faces the two grooves intended to receive the rope by which the block is to be suspended when in use: this operation is performed by means of two cutting tools, with curved edges, fitted at the opposite extremities of a small brass wheel which revolves on an axle by the connection of the latter with the steam-engine: the block is fixed in a frame in an inclined position, so that the cutting tools form a groove which commences near the pin-hole of the block and deepens gradually towards either extremity.

The sheaves are made of lignum vitæ, and plates of the required thickness being cut from the tree, each of them has a circular form given to it by means of a trepanning, or crown saw, a cylinder of steel having teeth on one of its edges, and having on its axle a tool for boring the centre hole through which the pin is to pass; the plate of wood being fixed in its place, the workman by a lever presses the saw and centre-bit against it; and these by revolving rapidly, both give a circular form to the plate and bore the hole in its centre.

The sheave is then to be prepared to receive in its centre the metal *coak* or ring through which the pin is to pass; for this purpose it is laid horizontally on a plate, which may be kept at rest, or turned round on its axis, as may be required; a drill, or cutting tool, in a vertical position, is made to form in succession three semicircular excavations of small depth at equal distances from one another about the centre hole. During the cutting of each of these the plate carrying the sheave is fixed, but in each interval it is turned one-third part round, by which means the tool is enabled to enlarge the centre hole to a small depth, quite round the latter; thus the side of the sheave is countersunk about its centre in the form of a circle having three segments cut in its circumference: the like countersinking then takes place on the other side of the sheave. The coak, which is made of

gun-metal and of a form to fit the countersink, is in two parts, one of them having a barrel which is to enter the centre hole; the parts are then introduced and riveted to the sheave. The middle part of the coak is then broached out so as to form a hole perfectly cylindrical; and, lastly, by a lathe also connected with the engine, the rope is formed round the circumference of the sheave.

The pins, which are of iron, are turned by a lathe of great strength, and are highly polished by being drawn with a revolving motion between two plates.

Some details have been necessarily omitted in the foregoing description, but enough are given to make the operation of these engines sufficiently clear to the general reader.

BLOCKADE, LAW OF. Whenever a war takes place it affects in various ways all states which have any connection with the belligerent powers. A principal part, accordingly, of the science of international law is that which respects the rights of such neutral states. For obvious reasons this is also the most intricate part of the subject. There is here a general rule, namely, that the neutral ought not to be at all interfered with, conflicting with a great variety of exceptions, derived from what is conceived to be the right of each of the belligerents to prosecute the object of annoying its enemy, even though (within certain limits) it inflicts injury upon a third party. In the first place, there is to be settled the question of what these limits are. It evidently would not do to say that the belligerent shall not be justified in doing anything which may in any way inconvenience a neutral power; for such a principle would go nigh to tie up the hands of the belligerent altogether, inasmuch as almost any hostile act whatever might in this way be construed into an injury by neutral states. They might complain, for instance, that they suffered an inconvenience when a belligerent power seized upon the ships of its enemy that were on their way to supply other countries with the ordinary articles of commerce. On the other hand, there is a manifest expediency in restricting the exercise of the rights of war, for the sake of the protection of neutrals, to as great an extent as is compatible with the effectual pursuit of the end for which war is waged. Accordingly, it has been commonly laid down, that belligerents are not to do anything which shall have a greater tendency to incommode neutrals than to benefit themselves. It is evident however that this is a very vague rule, the application of which must give rise to many questions.

It is by this rule that publicists have endeavoured to determine the extent to which the right of blockade may properly be carried, and the manner in which it ought to be exercised. We can only notice the principal conclusions to which they have come, which, indeed, so far as they are generally admitted, are nothing more than a set of rules fashioned on positive international morality (that is, so much of positive morality as states in general agree in recognising) by judicial decision. Accordingly perhaps the most complete exposition of the modern doctrine of blockade may be collected from the admirable judgments delivered in the course of the war which closed in 1815 by Sir W. Scott, afterwards Lord Stowell, while presiding over the High Court of Admiralty,[1] as] reported by Dr. Edwards and Sir Chr. Robinson. The extraordinary events of that time, and the extravagant decrees of the Emperor Napoleon, celebrated as the Berlin and Milan Decrees, and the ill-advised course of retaliation adopted by our government in the Orders in Council, to which specific reference will be made immediately, raised this point of international law into unusual, but in the circumstances not undeserved, importance. It engaged the attention of the British Parliament, and filled the political literature of the day. The various pamphlets and published speeches of Lord Erskine, Mr. Stephen, Mr. (now Lord) Brougham, Mr. Alexander Baring (afterwards Lord Ashburton), Lord Sheffield, and others, which appeared in the course of the controversy respecting the Orders in Council, may also be consulted with advantage. To these may be added various article in volumes xi., xii., xiv., and xix. of the 'Edinburgh Review,' particularly one in volume xix., pp. 290–317, headed 'Disputes with America,' written immediately before the breaking out of the war with that country.

The first and the essential circumstance necessary to make a good blockade is, that there be actually stationed at the place a sufficient force to prevent the entry or exit of vessels. Sir William Scott has said (case of the Vrow Judith, Jan. 17, 1799), "a blockade is a sort of circumvallation round a place by which all foreign connection and correspondence is, as far as human power can effect it, to be entirely cut off." This is in perfect accordance with the language of the convention signed between Great Britain and Russia in 1801; it states, "that in order to determine what characterises a blockaded port, that denomination is given only where there is, by the disposition of the power which attacks it with ships, stationary or sufficiently near, an evident danger in entering." Such a restriction as this, it is evident, is absolutely necessary to prevent the greatest abuse of the right of blockade. The benefit accruing to a belligerent from blockading its enemy's ports, by which it claims the privilege of seizing any vessel that attempts to touch or has actually touched at such ports, and the inconveniences thereby inflicted upon neutrals, would both, without such a provision, be absolutely unlimited. In point of fact, belligerents have frequently affected, in their declarations of blockade, to overstep the boundaries thus set to the exercise of the right. France, as Lord Brougham showed in his speech delivered before the House of Com-

mons, 1st April, 1808, in support of the petitions of London, Liverpool, and other towns against the Orders in Council, has repeatedly done so both since and previous to the Revolution. She did so in 1739, and in 1756, and also in 1796, in 1797, and in 1800. But in none of these instances were her pretended blockades either submitted to by neutrals or even, to any considerable extent, attempted to be enforced by herself. There can be no doubt that no prize court would now condemn a vessel captured for the alleged violation of any such mere nominal blockade. Accordingly, the language of the British government on this point during the last war with Russia was definite and firm beyond a doubt. In the royal declaration of the 28th of March, 1854, by which the British crown waived the right of seizing enemy's goods on board a neutral ship, these words were added: "We must support the right of a belligerent to prevent neutrals from breaking any effective blockade which may be established with an adequate force against the enemy's forts, harbours, or coasts." And finally, on the 16th of April, 1856, the Powers who were parties to the treaty of Paris of the same year, while yet assembled at Paris, agreed and solemnly declared that blockades, in order to be binding, must be effective; that is to say, maintained by a force sufficient really to prevent access to the coast of the enemy. And it was further agreed to invite the accession of the other States of the world to this and the other principles of maritime law adopted by these Powers at the same time. It has however been decided that the blockade is good although the ships stationed at the place may have been for a short time removed to a little distance by a sudden change of wind, or any similar cause; and no doubt the doctrine would still be maintained in this country, and it is likely too in the United States. But French publicists, now taking to the other extreme from that formerly pursued by their government, contend that this doctrine has the effect of giving to the mere notification the independent force of an effective blockade.

The second and only other circumstance necessary to constitute a blockade such as the prize-courts will recognise is, that the party violating it shall be proved to have been aware of its existence. There are two species of blockade: the one by the simple fact only of the place being surrounded by an effective hostile force; the other by a notification accompanied with the fact. These are attended with a corresponding difference of consequences. The effect of a notification to any foreign government would clearly be to include all the individuals of that nation; and ignorance of the blockade, though it might be a ground of appeal to the offender's own government for indemnity, could be no defence in the courts of the belligerent nation. After this, the mere act of sailing for the blockaded place is sufficient to constitute the offence of breach of blockade, and this although the intention to enter was contingent on the actual raising of the blockade. There is this further difference between these species of blockade: that in the case of a blockade *de facto*, when the fact ceases otherwise than by accident or shifting of the wind, there is immediately an end of the blockade; but where the fact is accompanied by a public notification from the government of a belligerent country to a neutral government, *primâ facie* the blockade must be presumed to exist till it has been publicly repealed. At the same time, it is always in the power of governments by treaty to modify the strict rights of war for a time, and to provide that vessels belonging to subjects of the treating powers and approaching the blockaded port shall be warned off and be suffered to retire with their cargoes, unless they have already had a previous warning and neglected it. Such a treaty was concluded between Great Britain and the United States in 1794.

With regard to neutral vessels lying at the place where the blockade commences, the rule is, that they may retire freely after the notification of the blockade, taking with them the cargoes with which they may be already laden; but they must not take in any new cargo.

The offence of violation is effected either by going into the place blockaded, or by coming out of it with a cargo taken in after the commencement of the blockade. Vessels must not even approach the place with the evident intention of entering if they can effect their object. It even appears that a vessel will render itself liable to seizure and condemnation if it can be proved to have set sail with that intention. In such cases, however, it must be always difficult for the captors to make out a satisfactory case.

After a ship has once violated a blockade, it is considered that the offence is not purged, in ordinary circumstances, until she shall have returned to the port from which she originally set out; that is to say, she may be seized at any moment up to the termination of her homeward voyage; and if she is chased, after such breach of blockade, by a belligerent vessel into her own or any other port, she continues liable to seizure on coming out again from that port. If the blockade, however, has been raised before the capture, the offence is held to be no longer punishable, and a judgment of restitution will be pronounced.

The effect of a violation of blockade to the offending party when captured, is the condemnation usually of both the ship and the cargo. If, however, it can be shown that the parties to whom the cargo belongs were not implicated in the offence committed by the master of the ship, the cargo will be restored. It has sometimes on the contrary, happened that the owners of the cargo have been found to be the only guilty parties, in which case the judgment has been for the condemnation of the cargo, and the restitution of the ship.

If a place, as generally happens in the case of maritime blockades, be

blockaded by sea only, a neutral may carry on commerce with it by inland communications. The neutral vessel may enter a neighbouring port not included in the blockade with goods destined to be carried thence over land into the blockaded place.

When a place has once been notified to be blockaded, a counter notice should always be given by the blockading power when the blockade has ceased. The observance of this formality is obviously conducive to the general convenience, but there are of course no means of punishing a belligerent for its neglect.

In this country a blockade is ordered and declared by the sovereign in council. It is held, however, that a commander of a queen's ship on a station so distant as to preclude the government at home from interfering with the expedition necessary to meet the change of circumstances, may have authority delegated to him to extend or vary the blockade on the line of coast on which he is stationed. But the courts will not recognise a blockade altered in this manner within the limits of Europe. It appears to be necessary for the sake of the public convenience that the power of declaring a blockade should, as far as possible, be exercised only by the sovereign power in a state; but it would perhaps be going too far to insist that it should in no circumstances be delegated to a subordinate authority. This would seem to be something very like interfering with the internal arrangements of states.

Some very important questions connected with the law of blockade were brought into discussion in the course of the French war by the Berlin decree of Bonaparte and the orders in council of the king of Great Britain.

The Berlin decree, which was issued on the 21st of Nov., 1806, declared the whole of the British islands in a state of blockade, and all vessels, of whatever country, trading to them, liable to be captured by the ships of France. It also shut out all British vessels and produce both from France and from all the other countries then subject to the authority of the French emperor. By a subsequent decree, issued soon after in aid of this, all neutral vessels were required to carry what were called letters or certificates of origin, that is, attestations from the French consuls of the ports from which they had set out, that no part of their cargo was British. This was the revival of an expedient which had been first resorted to by the Directory in 1796.

There can be no question as to the invalidity of this blockade, according to the recognised principles of the law of nations: the essential circumstance of a good blockade, namely, the presence of a force sufficient to maintain it, was here entirely wanting.

The first step in resistance to the Berlin decree was taken by Great Britain on the 7th of January, 1807, while the Whig ministry of which Mr. Fox had been the head was still in office, by an order in council subjecting to seizure all neutral vessels trading from one hostile port in Europe to another with property belonging to an enemy. This order however is said to have been extensively evaded; while, at the same time, new efforts began to be made by the French emperor to enforce the Berlin decree. It is admitted that in the course of the months of September and October, 1807, several neutral vessels were captured for violation of that decree; that a considerable alarm was excited among the mercantile classes in this country by these acts of violence; that the premium of insurance rose; and that some suspension of trade took place. (See 'Edin. Rev.' vol. xiv. p. 442, &c.) It was contended by the supporters of the British orders in council, that the effect of the Berlin decree upon the commerce of this country during the months of August, September, and October in particular, was most severely felt. (See Mr. Stephen's 'Speech.')

In these circumstances the British government, at the head of which Mr. Perceval now was, issued further orders in council, dated the 11th and 21st of November, 1807. These new orders declared France and all its tributary states to be in a state of blockade, and all vessels subject to seizure which were either found to have certificates of origin on board, or which should attempt to trade with any of the parts of the world thus blockaded. All neutral vessels, intended for France or any other hostile country, were ordered in all cases to touch first at some British port, and to pay custom dues there, after which they were, in certain cases, to be allowed to depart to their destination. In all cases, in like manner, vessels clearing out from a hostile port were, before proceeding farther on their voyage, to touch at a British port.

The predicament in which neutral countries were placed by this war of edicts was sufficiently embarrassing. The effect of the British orders in council is thus distinctly stated by a writer in the 'Edinburgh Review,' vol. xii. p. 229: "Taken in combination with the Berlin decree, they interdict the whole foreign trade of all neutral nations; they prohibit everything which that decree had allowed; and they enjoin those very things which are there made a ground of confiscation."

By a subsequent decree, issued by Bonaparte from Milan on the 27th of December, 1807, the British dominions in all quarters of the world were declared to be in a state of blockade, and all countries were prohibited from trading with each other in any articles produced or manufactured in the parts of the earth thus put under a ban. Various additional orders in council were also promulgated from time to time, in explanation or slight modification of those last mentioned.

It is asserted by the opponents of this policy of the British government, that the result was a diminution in the course of the following

year of the foreign trade of this country to the extent of fourteen millions sterling. It is even contended that, but for some counteracting causes which happened to operate at the same time, the falling off would have been nearly twice as great. (See 'Edin. Rev.' vol. xiv. p. 442, &c.)

The principal branch of trade affected was that with America, which was at this time the only great neutral power in existence; and which in that capacity had, previous to the Berlin decree, been an annual purchaser of British manufactures to a large amount, partly for home consumption, but to a much larger extent for the supply of the continent. Both the Americans, therefore, and the various parties in this country interested in this export trade, exclaimed loudly against the edicts of the two belligerent powers. It appears that the American government, on application to that of France, obtained an assurance, which was deemed satisfactory, though not in an official form, that the Berlin decree would not be put in force against American vessels; but when this was urged as a sufficient reason for the revocation of the English orders in council, the English government refused to pay any attention to it, maintaining that America should insist upon a public renunciation of the obnoxious French decree.

The subject was brought before parliament in March, 1808, by motions made in both houses asserting the illegality of the orders in council. On the 1st of April the merchants of London, Liverpool, and other towns, who had petitioned for the repeal of the orders, on the ground of their injurious operation upon the commercial interests of the country, were heard at the bar by their counsel, Mr. Brougham, whose speech, as has been already mentioned, was afterwards published. The result was, that ministers consented to the institution of an inquiry into the effect of the orders, in the course of which many witnesses were brought forward both by the petitioners and by the ministers in support of their respective views. But no immediate result followed, either from this inquiry, or from a motion made in the House of Commons on the 6th of March, 1809, by Mr. Whitbread, declaratory of the expediency of acquiescing in the propositions made by the government of the United States.

On the 26th of April however a new order in council was issued, which, it was contended by the opponents of the policy hitherto pursued, did in fact amount to an abandonment of the whole principle of that policy. On the pretext that the state of circumstances, so far as the Continent was concerned, had undergone a complete change by the insurrection of the Spaniards, the blockade, which had formerly extended to all the countries under the authority of France, was now confined to France itself, to Holland, to part of Germany, and to the north of Italy; and the order which condemned vessels for having certificates of origin on board was rescinded. On the other hand, the interdict against trading with the blockaded ports was apparently made more strict and severe by the revocation of the liberty formerly given, in certain cases, to neutral vessels to sail for an enemy's port after having first touched at one in Great Britain. Upon this point however some important modifications were made by subsequent orders. A system was introduced of licensing certain vessels to proceed to hostile ports after having first touched and paid custom-dues at a British port; and this was eventually carried so far, that at last the number of such licences granted is said to have exceeded 16,000.

The position however in which America was still placed was such as almost to force her to go to war either with England or France. In this state of things, in the spring of 1812 a vigorous effort was again made by the opposition in parliament to obtain the entire removal of the orders in council. In the Lords, a motion was made by the Marquis of Lansdowne on the 28th of February, for a select committee of inquiry into the effect of the orders, but was negatived by a majority of 135 to 71. On the 3rd of March a similar motion made in the Commons by Mr. Brougham was also rejected by a majority of 216 to 144. On the 3rd of April however an order of the prince regent in council appeared in the 'Gazette,' revoking entirely the former orders in so far as regarded America, but only on the condition that the government of the United States should also revoke an order by which it had some time previously excluded British armed vessels from its ports, while it admitted those of France. This conditional revocation being still considered unsatisfactory, Lord Stanley, on the 28th of April, moved in the Commons for a committee of inquiry into the subject generally, and the discussion ended by ministers giving their assent to the motion. Many witnesses were in consequence examined, both by this committee and by another of the Lords, which sat at the same time, having been obtained on the 5th of May on the motion of Earl Fitzwilliam. When the examinations had been brought to a close, Mr. Brougham, on the 16th of June, moved in the Commons, that the crown should be addressed to recall or suspend the orders unconditionally. At the termination of this discussion ministers intimated that they were prepared to concede the question; and accordingly, on the 23rd of the same month, an unconditional suspension of the orders, in so far as America was concerned, appeared in the 'Gazette.' By this time however the government of the United States had declared war, on the ground, as is well known, not only of the orders in council, but of other alleged acts of injustice on the part of the British government.

The policy of the British government in issuing the orders in council of November, 1807, was maintained by its opponents to be wrong, on

the double ground that it was both inexpedient and not warranted by the principles of the law of nations. On the latter ground they will no doubt be found in company with all jurists of any name; the text writers on the law of nations at this day are unanimous in their favour. But upon the former, the inexpediency of such a course as was pursued by our government on that occasion, there is not now a dissentient opinion throughout the United Kingdom. It is universally condemned as impolitic and short-sighted.

(Wheaton, *Elements of International Law;* Manning, *Commentaries on the Law of Nations;* Hautefeuille, *Droits des Nations Neutres;* Ortolan, *Diplomatie de la Mer;* Bynkershoek, *Quæstiones Juris Publici;* Grotius, *De Jure Belli et Pacis.*)

BLOCKADE. This consists in surrounding a fortified place by a cordon of troops, in order to prevent supplies of provisions or warlike stores from entering, and to compel the garrison to surrender from famine or the failure of their ammunition. The generality of the ancient sieges were blockades, and two of the most memorable in Grecian history were those of Platæa and Pydna. The former lasted two years, and is remarkable for being the first of which any connected details have been given. Pydna, in which city Olympias had taken refuge, was closely invested by Cassander both by sea and land, and did not surrender till the garrison had suffered the utmost extremity of famine.

When fortresses are situated on rocky eminences, whose sides are nearly inaccessible by nature, or have been made so by human labour; when they are approachable only by narrow passes, and the surrounding country is unfavourable for the execution of the works required in carrying on a regular siege; or when the besieging army is inadequately supplied with siege matériel, their reduction is most conveniently effected by a blockade, because they can be masked by a corps of troops not so numerous as to diminish materially the strength of the army in the field; and their garrisons, being necessarily small, are unable to attempt any serious enterprise.

In Europe, however, nearly all the old fortresses of this kind have been suffered to go to ruin, the smallness of their garrisons rendering them wholly useless; and therefore, since the end of the 17th century, blockades have been much less frequent than they were before that time. During the continuance of the war which was carried on by the Germans and Venetians against the Turks, and which ended with the peace of Carlowitz in 1698, several places were taken from the Turks after having been long invested; it was thus that, in Hungary, the fort of Agria and the towns of Mongatz and Great Waradin were taken by the Imperialists, and that in the Morea, the Venetian general obtained possession of Napoli di Malvasia.

Fortified towns may be blockaded when means are wanting to execute trenches and ricochet batteries; and when besides the place is known to be incompletely furnished with the necessary stores, and to contain a numerous or disaffected population within its walls. In such circumstances it may reasonably be expected that the place will in time be surrendered, particularly if it be the seat of an extensive commerce, or if the inhabitants should be disaffected to their government. The loss occasioned by the stoppage of the usual channels of trade; the discomfort arising from being confined within the fortifications; and, chiefly, the distress brought on by the scarcity and high price of the necessaries of life, never fail to produce dissatisfaction and even tumult among the citizens; and in the end the commander of the place is generally compelled by clamour, or induced by solicitation, to comply with the wishes of the people, and to deliver up his charge to the enemy.

In the establishment of a blockade, the outposts of the garrison are first driven as near as possible to the place, and the inhabitants prevented leaving; bodies of troops are disposed in convenient situations before all the accessible fronts; these are also strengthened at intervals by redoubts containing artillery, and if the place is on the sea-coast, a naval armament watches it on that side. Corps of cavalry and infantry occupy any villages on the several roads by which it may be attempted to throw supplies into the place; small advanced posts also watch the town closely, and maintain the communications between the different divisions of the blockading corps, by which means any movement of the garrison may be immediately discovered.

The blockading corps should also be supported by a reserve, established at a greater distance from the place, to seize any convoy approaching with succours for the garrison, or repulse any relieving force which may attempt to throw supplies into the place, or send assistance to any portion of the blockading army which, being attacked by a sortie in force, may require aid.

On the other hand, in order to counteract as much as possible the efforts of the enemy, all persons who cannot be rendered serviceable in the defence, or who cannot lay in a sufficient supply of provisions for their support during the probable continuance of the blockade, are sent out of the town; the necessary quantities of provisions and military stores are provided, and secured in casemates or shell-proof blindages, if a bombardment is apprehended, and the consumption of every article is carefully economised. The garrison should keep the field as long as possible, disputing with the enemy every spot which he may endeavour to occupy, driving in all cattle, and laying waste the country, and destroying everything which may afford him cover: sorties should be made whenever a hope of success presents itself without risking the loss of many men; and every other means should be taken as long as possible to prevent the enemy from establishing his posts, or forming redoubts about the place.

In 1757 the King of Prussia blockaded Prague, a populous city, and garrisoned by 60,000 soldiers; the investment continued six weeks, during which time all the avenues were occupied, and several engagements took place. The history of the late Peninsular war affords, however, one of the best examples of reducing a fortified town by a blockade, in that which the Duke, then the Marquis, of Wellington, caused to be established about Pampeluna in 1813. This town had a garrison consisting of more than 4000 men, while the British army could spare neither troops nor artillery sufficient to ensure its surrender by a siege. Nine strong redoubts, each capable of containing a garrison of 200 or 300 men, with some field-pieces, were constructed on commanding heights, at from 1200 to 1500 yards from the place, and served to repel every sortie from thence, while the rest of the blockading force was quartered in the neighbouring villages, or bivouacked beyond the range of the artillery of the fortress. Buildings near the latter were barricaded, and formed strong advanced posts; the roads were blocked up as usual, and small field-works covered the guards of the army. The blockade continued three months; and when Marshal Soult advanced to the relief of the town, notwithstanding that the British troops in concentrating themselves to oppose him were necessarily drawn away from the posts which they occupied, yet the precautions used were such, that no communication could take place between the garrison and the French army, though the latter was almost within sight of the ramparts.

(See Lallemand, *Traité des Opérations Secondaires de la Guerre;* Jomini, *Traité des grandes Opérations Militaires;* Colonel Sir J. T. Jones, *Journals of Sieges in Spain.*)

BLOCKHOUSE (also written BLOCKHAUS), among military edifices is, as the name implies, a building constructed chiefly of timber; if alone, it constitutes an independent fort; if formed in the interior of a field-work, it becomes a retrenchment or reduit, and serves to protect the defenders from the inclemency of the weather when the work is occupied during a considerable time, or to prolong the defence when the work is attacked; and, after it is taken, serves as an interior retrenchment which may prevent the enemy holding the works or enable the garrison to obtain a capitulation. Blockhouses have been principally employed in America, where from the abundance of wood they could easily be constructed. They are either one or two storied, but generally the former.

When the blockhouse is to be employed only as a retrenchment, its plan is generally a simple rectangle, and its walls consist of a single row of piles or timbers, placed upright in the ground, or, as generally made in America, of strong upright timbers at the angles, with walls of horizontal timbers, halved and notched into one another at the angles, where they overlap about six inches; these are pierced with loop-holes, at the distance of three feet from each other, in order that the building may be defended by a fire of musketry from within. The roof is formed by laying timbers horizontally across the inclosed area, and covering them with fascines and earth, or earth only. The covering materials, when the work is intended to be bomb-proof, must be at least four feet thick, since the shells fired from field-howitzers penetrate into earth nearly to that depth. The entrances, when formed in the walls, are protected by inclined blindages, or by palisades, planted close together in their front, and pierced with loop-holes; but occasionally the entrances are in the roof, and access to them is then obtained by means of ladders.

The interior breadth of the building should be about eighteen feet, in order to allow a passage between the two rows of bedsteads: these are placed with their heads to the side walls, and serve as banquettes on which the men may stand to fire through the loop-holes when the latter are much elevated above the floor, which they should be to prevent the enemy firing in through them.

Two-storied blockhouses are constructed usually by making an ordinary rectangular blockhouse with walls sufficiently strong to support an upper story of the same construction, which is put on askew, or with its sides parallel to the diagonals of the lower one. By this means a fire is obtained in front of the salients or along the capitals of the lower story, and the portions of the upper story which necessarily project over the lower one, being pierced with loop-holes downwards, act as a machiconlis and supply the want of a flanking fire. These, however, can only be used advantageously in situations where they will not be exposed to artillery fire.

Reduits of this kind are nearly indispensable in situations commanded by heights; when consequently the interior of the principal work is so subject to the plunging fires of the enemy, that the defenders could not otherwise find shelter, and then the side-walls should be thick enough to resist a fire of artillery. In other circumstances it would be advisable that the parapets of the principal work should conceal the reduit from the view of the enemy: for which purpose the roof of the latter should be kept as low as possible; and, in this case, in order to afford sufficient height in the interior, which should not be less than eight feet, it may be necessary to sink the floor below the natural level of the ground.

In a mountainous country the blockhouse possesses great advantages over an ordinary field-fort, inasmuch as the interior of the latter would

be incessantly ploughed up by the fire of artillery directed into it by the enemy from the surrounding heights. Here then the blockhouse may with propriety be constructed as an independent work; its plan may have re-entering angles, or be in the form of a cross, in order to allow the faces to be defended by flanking fires of musketry from within; and the walls may be thick enough to resist the shot from light or mountain artillery. For this purpose they must be made by planting parallel to each other, at the distance of three or four feet, two rows of strong piles, those in each row being close together, and the interval between the rows being filled with earth up to the height of the loop-holes, which should now be immediately under the roof of the building. The roof must be made shell-proof as before; but it has been recommended, when the work is not overlooked by the enemy, and when its breadth will permit, to have the piles forming the side-walls long enough to rise above the roof, and, either alone, or with a mass of earth behind them, to serve as a parapet.

To prevent the enemy from setting fire to the blockhouse, it should be surrounded by a ditch; part of the earth obtained from thence should be raised against the building as high as the loop-holes, in order to strengthen it exteriorly, and the rest may be thrown beyond the counterscarp to form there what is called a reverse glacis.

Any area inclosed for the purposes of defence by piles or palisades, or by logs of timber horizontally disposed, but without a roof, and defended by loop-holes and machicolations, is sometimes called a blockhouse: more generally, however, such constructions are called stockades, under which word they will be described.

(See Bousmard, *Essai Général de Fortification;* Dufour, *Mémorial pour les Travaux de Guerre;* Macauley, Captain J. S., *Treatise on Field Fortification.*)

BLOCKING-COURSE. [ENTABLATURE.]

BLOW-PIPE. The instrument to which this name has been applied was originally employed by jewellers and others in the soldering of metals on the small scale, whence it derives its name in the German language, "Löthrohr," from the two words "löthen," to solder, and "rohr," a tube or pipe. When used for such purposes it is constructed of a simple metallic tube seven or eight inches in length, the bore of which at the larger extremity is about one-fourth of an inch in diameter, and gradually contracts as it approaches the other, where it terminates in an almost capillary orifice; and the instrument is formed by simply bending this tube at a right angle at an inch or an inch and a half from its finer extremity. In this form it is used by the workman to direct the flame of a lamp on the portion of solder to be employed, by which he is enabled to bring it readily and without loss of time into a state of fusion; the solder is placed on a fragment of charcoal, which he holds in his left hand, and upon which the flame is made to play by blowing a gentle current of air against it by means of the pipe.

Such was its sole use until the year 1738, when, as we are informed by Bergman, Antony Swab, a Swedish bergrath, or counsellor of mines, and a man of very considerable knowledge for his time, introduced it to the notice of the scientific world, by employing it in determining the nature of the metals in the various ores and minerals which came under his notice. Swab however wrote no work on the subject, nor does it appear to have received any particular attention from any one until Cronstedt proposed his system of mineralogy, in which the arrangement is dependent on the chemical composition of the minerals. It thus became to him of vital importance for the general adoption of his system—we may almost say for its very existence—to possess some ready and simple means of determining the constituents of mineral bodies, as it was evident that those offered by the slow and laborious operations of chemical analysis could not be generally employed by mineralogists. This he found in the blow-pipe; and by the employment of fluxes in the experiments performed with this instrument, he may be considered as the founder of a new department of the chemical science. His results are to be found in his 'System of Mineralogy,' the first edition of which was published in 1758, and was translated into English by Von Engeström in 1765; also in an essay by the latter, published in London in 1770 under the title of 'An Essay towards a System of Mineralogy,' by Cronstedt, translated from the Swedish by Von Engeström, revised and corrected by Mendez da Costa, London, 1770.

The employment of the blow-pipe in detecting the constituents of minerals being thus brought into notice, excited the attention of the chemists and mineralogists to the cultivation of this branch of chemistry, and its application to chemical analysis and to the determination of the mineralogical species. In Sweden however it still appears to have been studied with the greatest success; and it is to the chemists and mineralogists of Sweden that we are indebted for the greater portion of the information which has been received on this subject, and more particularly to Bergman, Gahn, and Berzelius. Bergman, after extending its limits by a series of original researches, in which he investigated the properties of most of the then known species of minerals, and by a more general application to chemical analysis, published the results of his observations in a treatise written in the Latin language, which appeared at Vienna in 1779, under the following title: 'De Tubo Ferruminatorio, ejusdemque usu in explorandis Corporibus, presertim Mineralibus.' A translation of the above into English will be found in the second volume of Bergman's 'Chemical and Physical Essays,' by

Dr. Cullen, London, 1788. Gahn, though indefatigable in his observations and experiments with the blow-pipe, and though far exceeding any of his predecessors both in the conception and execution of his experiments, has however left no work on the subject. As an instance of his power of detecting the presence of metallic bodies, we are told by Berzelius that he has often seen him extract from the ashes of a quarter of a sheet of paper distinct portions of copper, and that too before the knowledge of the occurrence of this metal in vegetables was known, and therefore before he could have been led from this circumstance to suspect its presence in paper.

Although we cannot but feel regret at having received no work from a man so eminently qualified to instruct on this subject as Gahn, still we must consider ourselves most happy that under such circumstances the loss of the knowledge and experience of so long and laborious a life is not also to be lamented. Fortunately for science, accident, as it were, made Berzelius the medium through which this information was to be communicated to the world; and while his good fortune in thus having it in his power to add another to the many benefits he has bestowed on mankind cannot but be envied, it must be universally felt and acknowledged that if he was favoured by fortune he proved himself one of the most worthy of her favour by the manner in which he fulfilled the task assigned to him. The assiduity of Gahn in this study, together with the circumstances to which we are indebted for the preservation of his labours, cannot be better told than in the words of Berzelius himself. "Gahn," says he, "was never without his blow-pipe, not even during his shortest journeys. Every new substance, or any thing with which he was not previously acquainted, was immediately submitted to an examination before the blow-pipe; and it was indeed an interesting sight to observe with what astonishing rapidity and certainty he was thus enabled to determine the nature of a body, which from its appearance and exterior properties could not have been recognised. Through this constant habit of using the blow-pipe he was led to invent many improvements, and to make many conveniences, which he could have at hand whether at home or abroad. He examined the action of a number of reagents, for the purpose of finding new methods of recognising bodies; and this he did in such detail, and conducted his operations with such accuracy, that all his results may be relied upon with the greatest confidence. Nevertheless it never occurred to him to give a written description of his new or improved methods: he gave himself however all possible trouble to instruct all who were willing to learn, and many foreign men of science, who passed some time with him, have made known his great dexterity in this subject; but no one has communicated a perfect knowledge of his methods.

"I had the good fortune, during the last ten years of the life of this in many respects most remarkable man, to enjoy his most intimate acquaintance. He spared himself no trouble to communicate to me all the results of his experience, and I have consequently held it as a sacred duty to allow nothing of this experience and of his labours to be lost."

Such then is the origin of Berzelius's treatise, a work which must be considered as a very high authority on this subject; and as there are translations in the English, French, and German languages, we cannot too highly recommend it to the study of those desirous of obtaining a more intimate acquaintance with the uses to which the blow-pipe may be applied. The use of the blow-pipe has also been of late years much extended and simplified by Professor Plattner, whose work on this instrument is now doubtless the best extant. An English translation by Muspratt has recently placed this excellent treatise within the reach of all students.

As our limits will not allow of our entering into a very minute description of the phenomena presented by the different chemical elements and minerals when experimented on by the blow-pipe, we must confine ourselves chiefly to a general description of the nature of the experiments performed by this instrument, and the conclusions to which it leads in determining the chemical constitution of a mineral, and consequently in recognising to what species it belongs. For this purpose it may be convenient to class the experiments under four heads:—

1. The characteristic changes produced on bodies when exposed to a high temperature.
2. The deoxidising effect of the flame, and the reduction of metals from their ores.
3. The oxidising effect, or the changes produced by the oxygen of the air on the body.
4. The action produced by the application of fluxes or reagents.

The first three classes are dependent on the unaided action of the blow-pipe flame; and as the total effect is produced by properties peculiar to particular parts of the flame even in the cases where fluxes are employed, it becomes a matter of great importance to possess a good knowledge of the flame itself, a description of which will therefore be first given. If a burning lamp or candle be carefully observed, it will be found that the flame may be divided into four parts, which may readily be distinguished from each other. First, on the lower extremity of the flame, where it is in contact with the wick, will be seen a blue portion, which extends from the wick and terminates at the points *c, fig.* 1, where the boundaries of the flame assume a vertical direction. The second most striking part of the flame is the brigh

intensely luminous portion *b*, which rising as it were from out of the cup produced by the blue, ascends in the form of a cone. In close connection with this cone will be observed a smaller one (*a*) contained within it, of a dark colour, and rising from the upper extremity of the

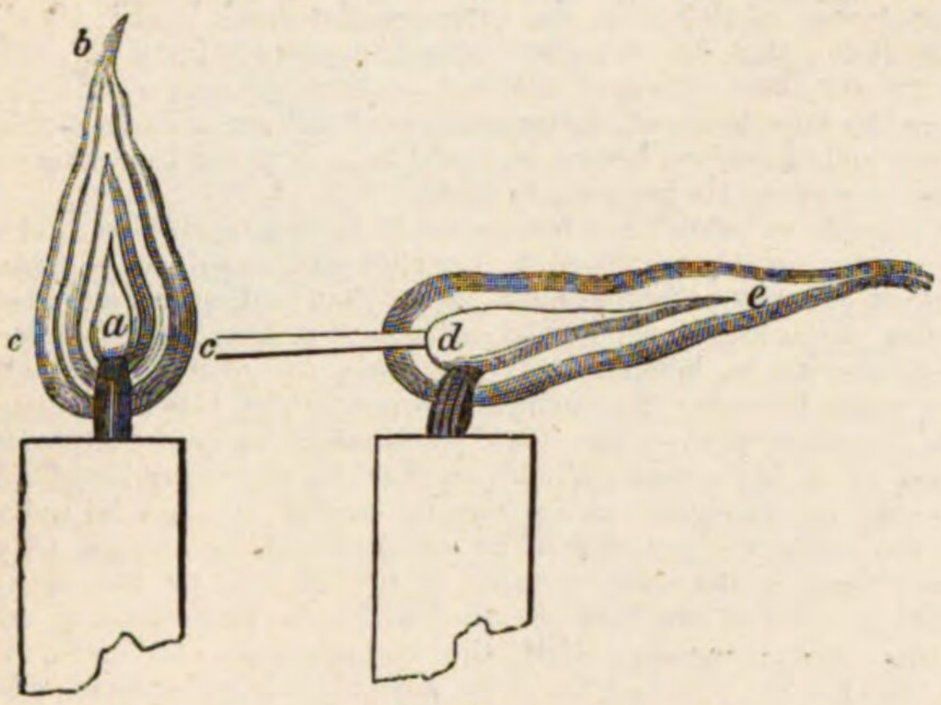


Fig. 1.

Fig. 2.

wick; and by a very careful examination it will be found that the outer surface of the luminous cone is bounded by a thin coating of a slightly luminous flame (*c b*), which forms the continuation of the blue ring, and increases a little in thickness as it approaches the upper extremity.

The three cones thus enveloping each other differ not only in their appearance, but also in their temperature and chemical condition. Flame, as was shown by Sir Humphry Davy in the course of his beautiful and philosophical inquiries into its nature, which terminated with the discovery of his safety-lamp, is gaseous matter heated to whiteness: its most striking properties are evidently its power of communicating light and heat, and however closely these may appear to be connected, the circumstances by which the one may be developed to its greatest extent in a flame are unfavourable to the production of the other. The explanation of this is simple and obvious: the heat depends on the rapidity and energy of the chemical combinations taking place; the light, on the contrary, on the quantity of the matter kept at the white heat, and on the length of time it remains in that state. If therefore into a stream of burning gas (to take a particular case, let it be coal gas) a jet of oxygen be conducted, the combustion will be immediately rendered more rapid, the temperature of the flame will consequently rise, while its illuminating power diminishes, as will probably have been observed by many who have seen the oxyhydrogen flames, where the light is derived only from the strongly heated chalk, not from the burning gases. On applying these views to the common flame, the existence of the three concentric cones will be readily understood: in the exterior cone, the inflammable gases arising from the decomposition of the burning material come in direct contact with the atmosphere, are well supplied with oxygen, and they consequently here undergo a more rapid combustion than the interior enclosed portions: here therefore will be found the hottest points of the flame. That such is really the fact may be proved experimentally, by holding a fine iron or platinum wire across the flame, when it will be found to glow most strongly in the points of its emergence from the luminous cone, and by holding the wire at different elevations in the flame, it will be found that the portion of the outer cone immediately above *c*, the upper ridge of the blue cup, is the point of greatest heat. In the most luminous cone the combustion is slower, and in the interior darker portion the gases have not yet come into contact with the air, and are still unchanged.

If a fine current of air be now directed into the flame by means of the blow-pipe, it will assume the appearance seen in *fig.* 2: in the centre of the flame, and immediately proceeding from the orifice of the tube, a long and thin blue portion in the position *d e* of the figure will be seen; this corresponds with the blue cup of the natural flame. But it was in the upper edge of this cup, in which were found the points of greatest heat, and the same is true here also, with this difference however, that while in the natural flame these points were spread over a considerable circle, *c c*, in the blow-pipe flame they are all collected into the one point *e*, where their united effect is of course proportionably great. The reason therefore of the high temperature which may be produced by the blow-pipe is the result of the concentration of the hottest points of the flame into a focus; and another circumstance tends also to heighten this effect, that while in the natural flame the points of greatest heat are on its outer boundaries, and are therefore rapidly robbed of their temperature, they here occur encased by the luminous flame which thus protects them against the loss of temperature from this cause.

The blow-pipe employed by the workman in the soldering of metals, and constructed as was first described, cannot be employed in these operations, owing to the collection of the water from the condensed moisture of the breath on continuing the blast any time. This inconvenience is avoided by making the blow-pipe of two pieces, and by interposing between these a receptacle for retaining the water, which is thus prevented from entering into the finer part of the pipe where it would obstruct the current of air. In using the blow-pipe the operator must not employ his lungs in producing the current of air, as it would not only be detrimental to his health, but he would be unable to sustain the blast a sufficient length of time to ensure the necessary effects: it is produced by inflating the mouth with air, which is then forced through the tube by contracting the muscles of the cheeks, and by a little practice the blast may be thus sustained for a considerable time, the process of respiration being unaffected, the only inconvenience arising from the fatigue of the muscles of the cheeks from their unusual exercise. The power of being able to perform this depends on the individual being able to keep his mouth inflated while he respires. After this has been learnt, some little experience will be required to enable the operator to regulate the strength of the blast, so as to produce the most powerful heat, as it must be neither too strong nor too weak; in the first case the heat is diminished in its action by an excess of air, and in the second too feeble a flame is produced.

We now proceed to the experiments themselves to which the blow-pipe may be applied, and we commence with those which fall under the first class: The changes produced on a body when exposed to a high temperature. Of these, four are particularly worthy of notice:—

Its fusibility.

The changes produced in its colour.

The volatilisation of the substance under examination.

The volatilisation of one or more of its component parts.

When the various elements or their compounds, which occur in a solid form at the usual temperature, for these alone can here be considered, are exposed to heat, there is always evidence of a force tending to overcome that cohesion of their particles to which they owe their solid form, and it is believed that by a sufficient degree of temperature any body whatever might be made to pass to the state of vapour, either immediately or through the intermediate stage of fluidity. However this may be, it is well known that the temperature at which such changes are effected, varies with each element, and the point which the blow-pipe first informs us upon is, whether the body is one of those which are unchanged or not at the degree of heat capable of being produced by means of it; and according to the result we know among what class of bodies the one under consideration will be found. Nor is this mere fact the sole guide to the knowledge of the body under examination; the facility or difficulty with which the change is effected, the characters of the substance in its changed form, the appearance it assumes on being again allowed to cool, open to us new sources of information, and each must be carefully observed. Thus, in some minerals the fusion is produced with ease; in others again, it can only be effected slowly, and by the strongest heat we can produce; while in a third case, our efforts will only be sufficient to round off the sharp edge of a fine fragment.

But these are by no means the most important changes, the relations of the elements to oxygen gas being decidedly more interesting and instructive. When any substance combines with oxygen gas it is said to be oxidised, and when a compound of oxygen with any base loses oxygen, it is said to be deoxidised, or reduced to a lower state of oxidation, according as it has lost the whole or a part of its oxygen. Most bodies, and particularly all the metals, are capable of undergoing the one or the other of these changes; and as by means of the blow-pipe we have it in our power to produce at pleasure the conditions under which a metal is liable to be oxidised, as well as those which are favourable to its reduction, should it be present in the form of an oxide; and as these changes are usually accompanied with striking and characteristic phenomena, the blow-pipe is thus the most powerful instrument in detecting the presence of metals, which may in many cases be extracted in their perfect metallic form from the smallest fragment of their ore.

The oxidation will be produced by holding the body before the outer extremity of the flame, where the elements being heated in contact with the oxygen of the air, are placed in the most favourable circumstances for combining with it. This takes place the more readily the further the assay is held from the flame, provided a sufficient temperature is at the same time obtained; nor is it necessary that this should be very great, since too great a heat is disadvantageous, particularly when the support is of charcoal. This process will be best performed with a pipe of comparatively large orifice, and when the material is kept at a low red heat.

The deoxidation or reduction requires a small orifice, and the substance under examination should be as much as possible surrounded by the luminous flame, by which means it is cut off from contact with the atmospheric oxygen, and is surrounded with a glowing combustible gas, by which it is deprived of its oxygen. In performing this operation, which is infinitely more difficult than that of oxidation, particular attention must be paid to keep the assay constantly in the luminous flame, as the action is but little assisted by the charcoal on which the substance rests. Berzelius recommends the beginner to practise himself in the reduction of metals by fusing small grains of tin on charcoal, and to endeavour to keep it in that state without allowing its surface to lose the metallic glance, which it does owing to the formation of the oxide, the instant it is removed from the deoxidising flame. This

operation should first be attempted on very small fragments, as the difficulty increases with the size of the tin grains.

We now come to speak of the experiments in which fluxes are employed, the most important of which and their uses will be briefly described. They are, carbonate of soda, borate of soda, the double phosphate of soda and ammonia, saltpetre, boracic acid, bisulphate of potash, gypsum, fluor-spar, nitrate of cobalt, tin, iron, lead. Of these the first three only are of general use, while the others are employed to test the presence of particular bodies; we shall confine our attention therefore to the former, as to touch upon the particular cases in which the others may be advantageous would not only lead us too much into detail, but belongs more particularly to the chemical description of the properties of these bodies.

Care should be taken that the carbonate of soda employed for these experiments be free from any impurities, particularly from the sulphate. The purest which can be purchased is the bicarbonate of commerce; if this cannot be obtained, a saturated solution of the ordinary carbonate should be taken, through which a current of carbonic acid must be transmitted, when the bicarbonate will be precipitated in the form of fine grains, which must be washed with cold water and then dried. It may be tested for sulphuric acid by means of the blow-pipe itself in the following manner: Let a glass be formed by fusing a portion of the carbonate of soda with a small quantity of pure silica, and let the resulting glass be well acted on by the deoxidising flame. If on cooling it retains its colourless condition, the soda may be considered free from sulphuric acid, the presence of which would be indicated by the glass assuming a yellow passing into a hyacinth-red colour, owing to the presence of the liver of sulphur. The application of carbonate of soda answers two purposes; to determine whether the body is fusible in it as a flux, and to assist in the reduction of metals. The carbonate of soda is best applied by mixing it in powder with the substance to be examined, which should also be in powder; the mixture is formed into a paste by the addition of a little water, a small portion of which must then be placed on the charcoal, where, after drying, it must be brought into a state of fusion. It is usual for the carbonate of soda, as soon as it is fused, to be entirely absorbed by the charcoal, but it is not on that account less active; a continued effervescence is observed on the substance under examination, and its fusibility is indicated by the formation of a glass globule.

But the greatest use of carbonate of soda is decidedly in promoting the reduction of metals, which it does in a most unaccountable manner. If a small quantity of the oxide of tin be placed on the charcoal, a dexterous blower, at some expense of time and trouble, will be able to obtain from it a small globule of metallic tin. If, however, a little carbonate of soda be added to the oxide of tin, the reduction is effected with ease and rapidity.

The influence of the carbonate of soda in this operation is not understood, but its action is constant; and Gahn has given the following process, by which the metals platinum, gold, silver, molybdenum, tungsten, antimony, tellurium, bismuth, tin, lead, copper, nickel, cobalt, and iron may be obtained, and consequently their presence detected, whenever they occur in any ore :—

The assay is reduced to powder, and formed as before into a paste with the moistened carbonate of soda; this must then be placed on the charcoal, and submitted to the action of a good reducing flame. After some time an additional quantity of soda salt must be added, and the blast must be again renewed, and this process must be repeated until the whole of the assay is absorbed by the charcoal. When this is entirely effected, those portions of the charcoal which have thus become saturated with carbonate of soda, must be moistened by a few drops of water; and they must then be carefully removed with a knife and reduced to powder in an agate mortar. This must then be washed, by which the fine and light particles of charcoal may be readily removed from the metallic particles, which, if any be present, will be found in a pure metallic form in the mortar. The form in which the metal will be found depends on its fusibility and malleability; should it possess these properties, it will be formed into small thin leaves; if not, it will be found as a metallic powder. By this process the operator should be aware that the metals antimony, bismuth, and tellurium may have escaped his observation, from having been volatilised as soon as reduced, which is also always the case with selenium, arsenic, cadmium, zinc, and mercury, which can only be obtained by sublimation.

The borate of soda of commerce is never sufficiently pure for these purposes, but it may readily be obtained fit for use by solution in pure water and re-crystallisation. It may be employed either in the form of small grains, or of powder, or it may be first fused to free it from its water of crystallisation. The advantages of its use in the blow-pipe are dependent on its forming a most powerful flux, by which a number of otherwise refractory substances may readily be brought into a state of fusion. It is usual, in the first place, to endeavour to fuse a small fragment of the assay; as, if this process be successful, we are able to observe the phenomena taking place during the fusion better than when it is applied in the form of a powder; and what is the most important, we see whether the assay is partially or entirely fusible in this flux. The principal facts to be observed are, whether the fusion is accompanied with effervescence, or whether it takes place tranquilly; to examine the colour of the glass when obtained, and the changes it undergoes according as it is acted on by the oxidising or reducing

flame, and also to observe whether any change takes place either in the colour or transparency of the glass as it cools.

The microcosmic salt, to use the term by which it is usually designated in works on this subject, is a double salt of phosphoric acid, ammonia, and soda. It is best prepared, according to Berzelius, by adding to a solution of 16 parts of chloride of ammonium in a small quantity of boiling water 100 parts of crystallised phosphate of soda: this latter must then be brought also to a state of solution over the fire, after which the solution must be immediately filtered, and then be allowed to cool slowly, when the double salt will be deposited as crystals. It may be considered as pure if the crystals when fused give a glass which does not become opaque on cooling. The object of this salt is to enable us to try the action of a free and strong acid on the assay, which is best obtained by this means, as on heating the ammonia is driven off, and the acid with which it was combined is then at liberty to exercise its influence on the body tested. It is therefore a powerful agent in proving the presence of the metallic oxides, with which it frequently forms characteristic coloured salts; and it is also a good test for determining the presence of silica in minerals, the phosphoric acid depriving it of the bases with which it was combined, and presenting it in the form of a gelatinous substance.

In subjecting metallic oxides to qualitative examination before the blow-pipe with the above-mentioned reagents, which fuse at the temperature employed, a stout platinum wire is bent in the form of an ear, of about one-sixth of an inch in diameter, around the tapering nozzle of the blow-pipe. Such a loop is then heated red hot, and plunged into the powdered flux which is to be used. The particles of flux which thus become attached to the wire, are again heated and made to take up some more of the flux, until enough of the latter is attached to form a bead filling the entire ear. Borax, microcosmic salt, and saltpetre give in this way transparent beads; carbonate of soda, and a mixture of this with nitre give a milky enamel; in all cases the bead so formed must be colourless.

The following table taken from Plattner's elaborate treatise on the blow-pipe, gives the reactions of the principal metallic oxides when heated in the oxidising and reducing blow-pipe flames, respectively with borax and microcosmic salt :—

	With Borax.		With Microcosmic Salt.	
	Reducing	Oxidising	Reducing	Oxidising
Baryta	Colourless.	Colourless.	Colourless.	Colourless.
Strontia	,,	,,	,,	,,
Lime	,,	,,	,,	,,
Magnesia	,,	,,	,,	,,
Alumina	,,	,,	,,	,,
Silicic acid	,,	,,	,,	,,
Sesquioxide of cerium	,,	Dark yellow.	,,	Yellow when hot, colourless when cold.
Manganese	,,	Violet.	,,	Violet.
Iron	Green.	Red when hot, yellow when cold.	Red when hot, yellow or red when cold	Yellow or red when hot, red or brown when cold.
Cobalt	Blue.	Blue.	Blue.	Blue.
Nickel	Opaque.	Violet when hot, red-brown when cold.	No change.	Brown-red when hot, red-yellow when cold.
Zinc	White enamel.	Colourless.	White enamel.	White enamel.
Cadmium	Colourless.	Yellowish white.		Colourless.
Lead	,,	Yellow when hot, colourless when cold.	Gray.	,,
Bismuth	Gray.	Colourless.	,,	,,
Uranium	Green.	Red when hot, yellow when cold.	Green.	Green.
Copper	Red and opaque.	Green when hot, blue-green when cold.	Dark green when hot, red-brown when cold.	Green when hot, blue when cold.
Silver	Gray.	Enamel.	Enamel.	Yellow.
Mercury	Volatilised.	Volatilised.	Volatilised.	Volatilised.
Platinum, gold	Reduced.	Reduced.	Reduced.	Reduced.
Tin	Colourless and reduced.	Colourless, or enamel.	Unchanged.	Colourless.
Antimony	Reduced and volatilised.	Colourless.	Reduced and volatilised.	,,
Chromium	Green.	Yellow-green yellow.		Red-green when hot, green when cold.

The alkalies, when heated by themselves in either of the blow-pipe flames, impart a colour to the flame which is probably the colour of

the vapour of the volatilised alkali. Potash colours the flame violet; lithia, red; and soda, yellow. The colouring power of soda being much greater than that of potash, a mixture of the two shows the reaction for soda. But if such a flame be looked at through a violet-coloured glass, the yellow light of the soda flame is absorbed, and the violet colour of the potassium is seen, even if only a small quantity of the latter metal be present.

Metallic tin is employed with difficultly reducible metals; its easy fusibility brings it in contact with the metallic oxides, and assists in their reduction.

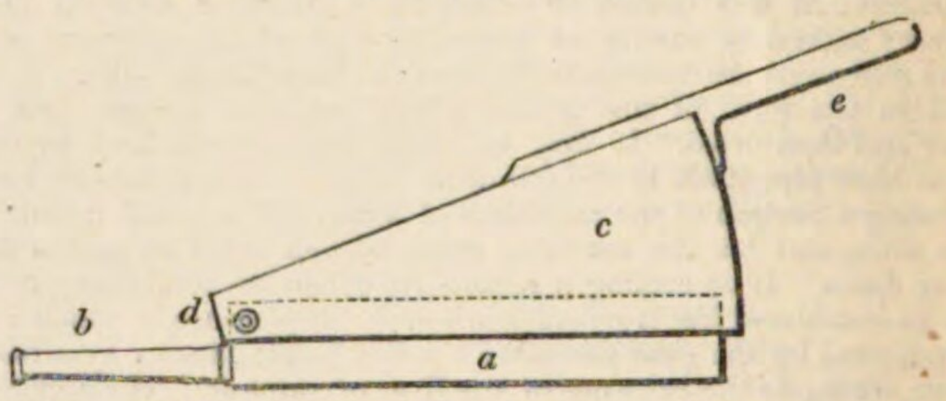
Nitrate of potash is used to effect the oxidation of those metals, whose higher oxides furnish characteristic compounds with the alkalies. Thus an oxide of chromium heated with nitrate of potash before the blow-pipe, yields chromate of potash; a yellow salt in which the chromic acid can be easily detected. Manganese furnishes, when heated with nitrate of potash and carbonate of soda, a characteristically green-coloured manganate of soda.

BLOWING-MACHINES are contrivances for producing a current of air for the purpose of exciting the requisite intensity of combustion for metallurgical and other operations which require great heat. The simpler kinds are described under BELLOWS; but the larger and more complex varieties are here noticed.

It will be remembered that the familiar implement, bellows, consists of an air-tight chamber of variable dimensions, having one aperture closed by a valve which can only open inwards, and another, which is connected either directly or indirectly with the nozzle, or pipe for the exit of the current of air, closed by a valve which can only open outwards. When, by the application of mechanical force, this chamber is distended or enlarged, the pressure of the external air opens the valve which opens inwards, and consequently the chamber becomes filled with air; but when, by an altered application of power, the chamber is compressed so as to reduce its capacity, the condensation of the included air causes the valve by which it entered to close, and that which opens outwards to open, so that the air escapes by the nozzle, with a degree of force and rapidity proportionate to the pressure employed in compressing the chamber. The leathern bag of the musical instrument called a bagpipe is an example of such a variable, or expansible and compressible, chamber, and would therefore, if fitted with a nozzle, form a substitute for the common domestic bellows; but the same effect is produced, in a much more convenient way, by the use of a chamber formed of two boards, the edges of which are connected by pieces of leather laid in folds in such a manner that the upper board may be raised or depressed at pleasure, while the lower board remains stationary.

The blast produced by such a machine as has been described is intermittent, and also variable in intensity. The first of these defects may be remedied by employing two separate bellows or pairs of bellows, worked alternately, so that the one may be expelling air while the other is drawing in a fresh supply. While, however, the blast thus produced is continuous, it is by no means equable in force. To remedy this defect the air expelled from the chamber already described should be forced into a second chamber, like it, of variable dimensions, but compressed by a weight so as to produce a constant steady pressure; and the nozzle should be made to open into the second chamber. In forge-bellows of this construction there are three boards, connected by leather sides which are kept in regular folds by hoops of cane. The middle board is fixed in a horizontal position, and has the nozzle attached to it, while the upper and lower boards are moveable, and are loaded with weights; the effect of which is that when the machine is at rest the chamber formed between the upper and the middle boards is collapsed, while that between the middle and the lower boards is distended and full of air. When in use the lower board is raised by means of a lever and chain, and the air enclosed between it and the middle board is forced through a valve into the upper chamber; and by the rapid repetition of this action the upper chamber is filled with air more rapidly than the nozzle can carry it off, so that the upper board rises. The working of the bellows may then be suspended for a time; seeing that a continuous and equable blast will be maintained by the pressure of the loaded upper board until it has, by the complete expulsion of the air, descended to its original position. It should be remembered that this perfect equability of blast is only maintained while the working of the bellows is suspended, because during that time the blast is produced solely by the pressure of the loaded board; while, during the working of the bellows, the pressure alternates between that and the superior pressure produced by the influx of air from the lower chamber, thereby causing the upper board to rise and fall with each stroke. Many smiths' bellows are made of the pear-shaped form common to hand-bellows, and have the boards, or at least the lower and middle boards, united by a kind of hinge-joint; but the superior machines of this description have the boards circular, and the working apparatus so arranged as to make their action parallel; and in some cases, as for portable forges, helical springs are applied to the boards in lieu of weights.

Beckmann ('History of Inventions') observes that large bellows, such as were formerly used in smelting-houses, when made with leather, were attended with many inconveniences. They require careful management and expensive repairs, and wear out after a few years' use; the leather needs to be frequently greased or oiled, in order, if it be thin, to prevent the enclosed air from passing through it, or, if thick, to keep the leather soft and pliable, and prevent it from cracking in the folds. These defects led to the invention, apparently in Germany, in the 16th or 17th century, of bellows formed entirely (excepting the nozzle and hinge-joint) of wood; these were long used in metallurgic operations on the Continent, and appear, from what Beckmann says as to their efficiency, to be well adapted for use where more perfect machines are unattainable. The annexed cut, representing a side elevation of such an apparatus, will sufficiently explain the structure of wooden bellows. In this figure *a* represents a wooden box of an oblong square form, the upper edge of which is indicated by dotted lines. It is open at the top, and from one end of it proceeds the nozzle *b*, which, as well as the bottom board of the box, is supplied with a flap-valve, like common bellows. This box is fixed in a horizontal position, and is covered by the box *c*, which is open at the bottom, and is so much larger than *a* as to allow its sides to slide up



and down outside the sides of the lower box without actual contact. The two boxes are united at the nozzle end by a hinge-joint formed by the bolt *d*, and the upper box is capable of being worked up and down by the projecting handle *e*. Great friction would be occasioned if an attempt were made to obtain a close fit by the accurate adjustment of the boxes one to the other; and it would be impossible, in consequence of the shrinking and warping of the wood, to make the machine air-tight; but this difficulty is obviated by attaching thin slips of wood to the inner sides of the box *c* in such a manner as to fill up the space between the two boxes: such slips being rendered very flexible by cutting them nearly through with a saw at intervals of fifteen or eighteen inches, and by being pressed into close contact with the sides of the box *a* by small metal springs. The same object might be readily effected by slips of leather. Wooden bellows of this construction are both cheap and exceedingly durable, the slips or laths which render them air-tight being the only part liable to wear; and these are easily replaced. Though we find no notice of such a modification of them, a very trifling exercise of ingenuity would be sufficient to form double bellows of this simple character. The Rev. John Williams, when serving his life of usefulness as a missionary in the South Sea Islands, taught the natives how to make a blowing-machine. This apparatus, invented by him in the absence of any available information respecting such contrivances, consisted of two square boxes containing pistons that were alternately raised by levers, and suffered to fall by their weight, aided by a load of stones; the whole forming a rude imitation—rather of the cylinder blowing-engines now used in iron-works, than of common bellows.

A very different kind of blowing-machine, which appears to be of French origin, and has been much used for blast-furnaces on the Continent, and also, we believe, in the United States of North America, though it does not appear to have been much adopted in this country, is the water blowing-engine, otherwise called *trombe* or *trompe*, in which water is allowed to fall in a minutely divided stream by passing through a colander, or by some other contrivance, down a large tube in the sides of which, near the upper end, are several apertures for the admission of air. In so falling the water draws with it a great quantity of air, which passes with it into a vessel at the bottom of the pipe, where the water dashes upon a pedestal which disperses it through the vessel. By this action the separation of the air and water appears to be facilitated; and consequently the air collects in the upper part of the vessel, whence it is conducted by a pipe to the furnace; while the water escapes by apertures provided for the purpose in the lower part of the vessel. The action of this kind of blowing-engine, which is represented in several different forms, has been variously explained by different writers; the powerful current of air produced by it has been compared to the wind which accompanies violent showers of rain. It is worthy of remark, as probably indicative of the origin of its name, if not also of the invention of this apparatus, that its French name *trombe* is the same as that of the meteorological phenomenon which we call a water-spout.

The great improvements which have been effected in the iron manufacture within the last century are, in a great measure, due to the introduction of very powerful blowing-machines, in which the air is alternately drawn into and expelled from large cylinders, resembling those of a steam-engine, by the action of pistons impelled by a connection with water-wheels or steam-engines. The first blowing-machines or force-pumps of this character on a large scale were those of the Carron foundry, constructed by Smeaton, and set to work in the year 1760. The arrangement of the piston and valves is so similar to that of a steam-engine cylinder as to need no detailed description. In

some cases, where steam is the moving power, the piston-rod of a double-acting blowing-cylinder (in which a blast is produced by every stroke, whether upwards or downwards), is connected directly with the vibrating beam of a steam-engine; in others the motion is transmitted through a series of cranks, so that two, three, or four blowing-cylinders may be worked in succession. These generally force the air into an air-chest of large dimensions, which is usually formed of iron, but sometimes of masonry, and from which it is conducted to the blast-pipes, which are called *tuyeres* or *tweers*. Barlow, in his 'Treatise on Machinery and Manufactures,' part of the 'Encyclopædia Metropolitana,' described a very powerful blowing-machine at Woolwich Dockyard, in which four cylinders supplied air, at a pressure of a quarter of a pound to the square inch, to a large air-chest from which pipes extended to all the forges and fires in the smithy, the pipes being supplied with cocks by which the blast could be turned off or on at pleasure. To ensure equability of pressure, a regulating cylinder, with a piston loaded to the required pressure, was used; and whenever the pressure exceeded the required amount, it raised the piston, and the air escaped like steam from a safety-valve. Owing to the using of sliding instead of clack or flap-valves in the blowing-cylinders, this machine worked very quietly. Another mode of regulating the blast is to throw the air from the cylinders into a large iron box inverted in a cistern of water, and somewhat resembling a gasometer, but so fixed as to be incapable of motion. The effect therefore of the condensation of air in the box is to force some of the water out; and the difference between the level of the water within and without the box forms a measure of the degree of condensation or pressure. In using such an apparatus care must be taken to conduct the air-pipes at so high a level as to render the forcing of water into the furnace impossible. The blast thus produced is exceedingly cold, which is a great disadvantage in a smelting-furnace. For a notice of the advantages of a hot blast see IRON MANUFACTURE.

The *water-bellows* is a simple kind of blowing-machine the invention of which we have seen attributed to Hornblower, one of the early English improvers of the steam-engine. It consists of two iron boxes, or hollow vessels with their under sides open, suspended from the opposite ends of a vibrating beam, resembling that of a steam-engine. The lower edges of these vessels dip into two cisterns of water, within which, rising above the surface of the water, are pipes connected with the blast or air chamber. When, by the motion of the beam, one of the vessels is forced down into the cistern, it compresses the air enclosed between it and the surface of the water, and consequently forces it along the blast-pipe. The other vessel, meanwhile, as it rises admits a fresh supply of air through a valve which opens inwards; and this air is forced into the blast-pipe in like way when the action of the beam is reversed. Another machine of similar character, but still more simple, consists of a cask or cask-like vessel suspended on an axle in a horizontal position, so as to be capable of an oscillating motion. This cask is divided longitudinally by a vertical partition, reaching from the top very nearly to the bottom, and is about half filled with water. When the cask is turned a little upon its axis, as the water retains its level, the air at one side of the partition is condensed, and escapes through a valve into a pipe which conducts to the air-chamber or reservoir; while, owing to the enlargement of the space on the opposite side of the partition, air enters it through a valve opening inwards. On reversing the inclination of the cask, the case is reversed, and the air which entered before is expelled, while a fresh supply is drawn in on the opposite side of the partition. This is the most simple form of the apparatus, but far more perfect and more complicated machines are constructed on the same principle.

Barlow, in the 'Treatise' above cited, described a simple and powerful blowing-machine used at Sharp and Roberts's engine manufactory, at Manchester, which may be compared to an Archimedean screw, excepting that, instead of raising water, its object is to impel air. It is partly immersed in a reservoir of water, and is turned by a steam-engine. Vaughan's blowing-machine is a well-contrived substitute for a cylinder and piston engine, in which the required effect is produced by the backwards and forwards motion of square pistons in two oblong boxes, placed side by side, each of which may be compared to a double-acting cylinder. This contrivance is based upon the rude bellows used by Chinese smiths. Blowing-machines in which the current is produced by means of fanners are noticed in BELLOWS; and their application to steam-carriage furnaces is alluded to in STEAM-CARRIAGE.

BLUBBER. [WHALE FISHING.]

BLUE, as a pigment. The substances used for this purpose are of very different natures, and derived from various sources: they are all compound bodies, some are natural and others artificial. They are derived almost entirely from the vegetable and mineral kingdoms, though the first which we shall describe is partly prepared from animal matter, namely:—

Prussian Blue.—This beautiful pigment was discovered by accident in 1710, by Diesbach, a manufacturer of Berlin; but the method of preparing it was first described by Woodward in the 'Philosophical Transactions' of 1724. The first step in the operation is to calcine a mixture of potash or its carbonate, with animal matter that contains nitrogen, as blood, hoofs, or horns, in an iron vessel, till it ceases to burn with flame. The residual matter is then suffered to cool, the

soluble portion of it dissolved in water, and the solution, when sufficiently concentrated, yields fine yellow crystals on cooling. This salt, commonly called ferrocyanide of potassium, or prussiate of potash, is a double cyanide of potassium and iron, consisting of

2 Equivalents cyanide of potassium	129·9
1 Equivalent cyanide of iron	54·0
3 Equivalents water	27·0
	210·9

When a solution of this salt is poured into one of protosulphate of iron, a perfectly white precipitate is formed, provided no persulphate be present; but if the latter salt be present, then the precipitate is of a bluish-gray colour; in both cases it becomes, by exposure to the air, of a fine blue, and is then washed and dried for use. The chemical change by which the white precipitate is produced may be thus expressed:

$$\underbrace{2(FeCy+2K\,Cy)}_{\text{Prussiate of Potash.}}+\underbrace{2FeO\,SO_3}_{\text{Protosulphate of Iron.}}=\underbrace{(FeCy+2K\,Cy)+3FeCy)}_{\text{White Precipitate.}}+2KO\,SO_3.$$

And on exposure to air, the white precipitate becomes oxidised and converted into ferrocyanide of potassium, which dissolves, and basic Prussian blue. Neglecting the ferrocyanide of potassium, this change may be thus expressed:

$$\underbrace{9FeCy}_{\text{Cyanide of Iron.}}+O_3=\underbrace{(Fe_7Cy_9+Fe_2O_3)}_{\text{Basic Prussian Blue.}}$$

The action of strong acids removes the sesquioxide of iron (Fe_2O_3), leaving ordinary Prussian blue ($Fe_7Cy_9=2Fe_2Cy_3+3FeCy$).

Very commonly the solution of cyanide of potassium and iron, procured from the residue of the calcination, is not put to crystallise, but is added at once to the solution of sulphate of iron. In this case, on account of the excess of potash which it contains, a portion of iron in a state of oxide is precipitated uncombined with the colouring matter; in order to prevent this from injuring the colour of the pigment, either dilute sulphuric acid is added, which dissolves it without acting on the Prussian blue; or alum is mixed with the sulphate of iron, and the uncombined potash uniting with its sulphuric acid, alumina is precipitated instead of oxide of iron, which merely dilutes without otherwise injuring the colour of the product. When a solution of a persalt of iron, such as the nitrate, is used, the precipitate is immediately obtained of a fine blue; but this process does not answer in manufacturing.

Prussian blue is inodorous, tasteless, insoluble in water, alcohol, ether, and oils. It is hygrometric, attracting water strongly from the air, which it retains until heated to nearly 280°. Diluted acids do not act upon this substance; but strong sulphuric acid dissolves it, forming a white compound similar to that of starch and water in appearance. On the addition of water the blue colour is restored. Nitric acid and hydrochloric acid, when concentrated, both decompose it, and the same effect is produced by the alkalies and alkaline earths, but with different results. It is also decomposed by a strong heat. Prussian blue is employed both as a water colour and in oil; in the latter case, on account of the deficiency of what is termed *body*, it is usually mixed with white lead, and it will bear admixture with a large portion of this, on account of the intensity of its colour. Its stability is very considerable, and it is not only used as a pigment but also as a dye. According to Berzelius, it was used in Sweden instead of smalt, to give writing-paper a blue tint, but the paper was found to acquire a disagreeable greenish hue.

Indigo.—This fine blue is extracted from different species of *indigofera* in the East Indies and Guatemala in South America. For the methods of procuring the colour from the plant, and the various substances with which it is mixed, we refer to the article INDIGO, here merely stating the properties of the blue pigment usually met with by that name in small cubic pieces. The colour is extremely deep, the fracture is earthy, but becomes brilliant and of a copper-red colour when rubbed by a hard body, and according to the degree to which this effect is produced, the better is the indigo reckoned. Even in this state, however, it is mixed with some foreign matters, which may generally be separated by water, alcohol, solution of potash and dilute acid, in all of which pure indigo is insoluble. It may also be purified by sublimation, but the process is difficult of management, for if the heat be rather greater than necessary, the indigo is decomposed. Another method of procuring pure indigo is to take the solution of indigo prepared by dyers, and agitate it in contact with atmospheric air. This solution is prepared by mixing blue indigo in powder with lime and a solution of protosulphate of iron; the lime decomposes the sulphate of iron, precipitating its protoxide; this acting upon the indigo, in the presence of water causes it to combine with hydrogen, by which it is rendered colourless and also soluble in water; if this solution be agitated with atmospheric air, the indigo, becoming dehydrogenised and regaining its colour, is precipitated, and when washed with a little dilute hydrochloric acid and dried, it is pure. Indigo, except when used as a water-colour, requires white lead to give it body; it is a colour of considerable permanency. Strong nitric acid decomposes it, but it

differs from most vegetable products, and especially vegetable colours, in being perfectly soluble in concentrated sulphuric acid. The colour is most intense, and this solution is employed in dyeing what is called Saxon blue. Several compounds are here formed, which will be described under the head of INDIGO.

The colour of indigo is entirely destroyed by chlorine, and also by chromic acid and oxidising agents in general.

Blue Verditer.—This pigment is used as a water-colour, and chiefly in the manufacture of paper-hangings. It is a gritty powder of a very fine light blue, and consists of carbonate of copper united with water. It is prepared by precipitation from the solution of nitrate of copper which results from the refining of silver by precipitating the silver with copper. The exact mode of operating is not generally known, and success probably depends upon some minute circumstance in the manipulation.

This colour is readily acted upon by the acids even in their dilute state; they evolve its carbonic acid, and dissolve the oxide of copper; the alkalies, potash and soda, and lime-water, combine with the carbonic acid, and separate oxide of copper; it is blackened by sulphuretted hydrogen, and it is decomposed at a high temperature. It ought, therefore, not to be used by artists.

Ultra-marine.—This splendid and permanent blue pigment was originally, and indeed until within a few years exclusively, prepared from a mineral called Azure Stone, or Lapis Lazuli, the finest kinds of which are brought from China, Persia, and Great Bucharia. In the 89th vol. of the 'Annales de Chimie,' M. Tassaert has noticed the accidental formation of ultra-marine in a furnace used for the manufacture of soda; and about the year 1828, M. Gmelin of Tübingen, and M. Guimet of Lyons, both succeeded in forming this colour artificially, and it is now prepared in large quantity, of quality equal to the natural product. The former of these chemists has given the following process for making this pigment, and he asserts that it will infallibly succeed: Prepare hydrate of silica and alumina, the first by fusing powdered quartz with four times its weight of carbonate of potash, dissolving the fused mass in water and precipitating the silica by hydrochloric acid; the second by decomposing a solution of alum with ammonia. Wash these two earths carefully with boiling water; and by drying portions of the moist precipitates, ascertain the quantity of dry earths which they contain. Then dissolve as much of the hydrate of silica as a solution of soda will take up, and determine the quantity. Lastly, for 72 parts of anhydrous silica take 70 parts of dry alumina, add them to the alkaline solution of silica, and evaporate, constantly stirring till the residue is nearly dry: this is the basis of the colour.

Put into a Hessian crucible, which has a cover that fits closely, a mixture of two parts of sulphur and one part of anhydrous carbonate of soda; cover and heat the mixture moderately till it fuses; then gradually throw in small portions of the mixture above described, waiting till the effervescence is over before a fresh portion is added. Keep the mixture at a moderate red heat for an hour. If there be an excess of sulphur it is to be expelled by a moderate heat, and if all parts should not be equally coloured, the finer portion after powdering may be separated by washing with water, 'Annales de Chimie et de Physique,' 37, 409. According to the author of this process, sulphuret of sodium is the colouring principle of the lapis lazuli, and of course of the artificial as well as the natural ultramarine.

This pigment loses its colour totally by being put into an acid, and although there is no perceptible effervescence, a slight smell of sulphuretted hydrogen gas is recognised; the residue is of a dirty white colour; the alkalies do not act upon this colour, nor is it destroyed by exposure to a red heat.

It was formerly, on account of its high price, used almost exclusively by artists, both as a water-colour and in oil; but the reduced charge at which it is now made has caused it to be extensively employed by paper-stainers and calico-printers.

Thenard's Blue.—This was proposed as a substitute for ultra-marine before the invention above described had rendered this latter colour easily obtainable at a moderate price. According to Thenard ('Traité de Chimie,' tome i.) this pigment, the base of which is either a phosphate or arseniate of cobalt, is prepared by adding a solution of phosphate of soda to one of nitrate of cobalt; the precipitated phosphate of cobalt, after due washing, is to be mixed with moist hydrate of alumina, the proportions being one of the phosphate to eight parts of the hydrate; or half the quantity of arseniate of cobalt may be substituted for the phosphate.

These substances are to be thoroughly mixed and then dried in a stove, and when the mass has become brittle it is to be calcined in a covered crucible at a cherry-red heat for half an hour.

This colour is one of great permanence, but is not so fine as the ultramarine, and is not now much used.

Smalt is a blue colour also prepared from cobalt, but is generally used rather to diminish the yellow tint of writing paper and of linen, and to give a bluish colour to starch, than strictly speaking as a pigment; it is merely glass rendered blue by oxide of cobalt, and this when reduced to a very fine powder is commonly called *powder-blue.* [COBALT.]

BLUE, PRUSSIAN. [BLUE.]

BLUE VITRIOL. [COPPER, SULPHATE OF.]

BLUNDERBUSS. [ARMS.]

BOARD, a word used to denote, in their collective capacity, certain persons to whom is intrusted the management of some office or department, usually of a public or corporate character. Thus, the lords of the treasury and admiralty, the commissioners of customs, the lords of the committee of the privy council for the affairs of trade, &c., are, when met together for the transaction of the business of their respective offices, styled the Board of Treasury, the Board of Admiralty, the Board of Customs, the Board of Trade, the Poor-Law Board, &c. The same word is used to designate the persons chosen from among the proprietors to manage the operations of any joint-stock association, who are styled the Board of Directors. In parochial government the guardians of the poor, &c., are called the Board of Guardians, &c. The word *bureau* in France is an equivalent expression.

BOAT. [GUN-BOAT, LIFE-BOAT, MORTAR-BOAT, &c.]

BOATSWAIN, a warrant officer in a ship of war who has the care of the rigging, cables, cordage, anchors, sails, boats, flags, colours, and other stores, which are committed to his charge by indenture from the surveyor of the navy. One of the chief duties which devolve upon this officer is to attend to the rigging of the vessel, which he is charged to inspect every morning; not only to observe that everything is properly fitted and arranged in its place, but to see that all things are in good condition, to remove whatever may be judged unfit for service, and to supply whatever may be deficient. He cannot however cut up or otherwise appropriate any cordage or canvas for the public uses of the ship without a written order from the captain, and under the inspection of the master. His instructions inculcate the utmost frugality in the use of the stores intrusted to him; and at the end of a voyage he must present to the surveyor of the navy minute accounts, previously audited and vouched by the captain and master, of the purposes to which all the stores in his department have been applied, or of the circumstances under which they may have been lost, stolen, misapplied, or returned to the dock-yard. He cannot receive his pay till his accounts have been approved.

In this department the boatswain is much under the control of the master; his more exclusive function is that superintendence and control which he exercises over the men. He summons the crew to their duty, assists with his mates in the necessary business of the ship, and relieves the watch when its time expires. His calls on the crew are made by a silver whistle of a peculiar construction, well-known as the "boatswain's call." He must observe that the men attend when called, and that they properly perform their duties; and he is enjoined to observe, "that the working of the ship be performed with as little noise and confusion as possible." The boatswain is a sort of provost-marshal in the ship, inflicting such punishments as may be awarded by the captain or by court-martial. These latter functions he performs through his mate, whose office is perhaps the most unpopular in the navy. The boatswain is the examiner of seamen and boys before they attain higher ratings, and is indeed considered in all things to be a thoroughly practical and finished seaman. His influence in a ship is immense, and the discipline of the crew and the comfort of the ship depend greatly on his tact and temper, his firmness and judicious forbearance. Hence his position (together with that of the other warrant officers) is attracting the attention of the authorities, and measures are already in contemplation to restore his position which, till 1844, was next in rank below second masters, and also his pension, which was discontinued in 1830. Boatswains and the other warrant officers [WARRANT OFFICERS] frequently at sea keep a lieutenant's watch, and henceforward they will, for highly meritorious conduct, be allowed to hold commissions in her Majesty's fleet if competent to pass a certain examination, and the Admiralty allows the sum of 100*l.* to cover the expense of outfit on such occasions. The sea pay of a boatswain varies from 4*s.* 9*d.* to 6*s.* 7*d.* per day, according to his class and rate of ship. The number of his mates varies from four to one, according to the size of the vessel, and their pay is that of a chief petty officer.

(*Regulations and Instructions relating to her Majesty's Sea Service;* Harris's *Lexicon Technicum: Table of Naval Allowances,* &c.)

BOBBIN-NET AND LACE. [LACE.]

BOCLAND, land held by book or charter. The two great distinctions of lands in the Anglo-Saxon times were those of boc-land and folc-land. The former means land which had been severed from the folc-land, and converted into an estate of perpetual inheritance. Folc-land, on the other hand, was the property of the community. Sir Henry Spelman describes folc-land as "terra popularis, quæ jure communi possidetur—sine scripto." ('Glossar.' v. Folcland.) In another place (v. Bocland) he says, "Prædia Saxones duplici titulo possidebant: vel scripti authoritate, quod Bocland vocabant—vel populi testimonio, quod Folcland dixere." Folcland might be held in severalty or occupied in common, but could not be alienated in perpetuity. Where held in severalty it was probably granted by the folcgemot or district court, or bestowed as a reward for some public service, and was subjected to certain burdens beyond the military service and the maintenance of fortresses, bridges, and roads, exacted from all landed possessions, such as repairing the royal vills, furnishing carriages and horses to the sovereign and other great men on their journey, receiving travellers, &c. (Lappenberg's 'Geschichte von England;' J. M. Kemble's 'Saxons in England;' and his 'Codex Diplomaticus Ævi Saxonici,' Introduction.)

The author of 'A Dissertation on the Folclande and Boclande of the Saxons,' 4to., Lond. 1777, says, "the Boclande and Folclande are first discovered in an ordinance of Æthelbert, which informs us that the country was divided into two portions, one of them more immediately appertaining to the King and his Thains, the other under the jurisdiction of the Earl, who was annually elected by the freemen of every shire, and was denominated Eorl, Ealdorman, or Gerefa, and in latter times Greve, or Reve; he it was that convened the Folcmote, which was composed of the possessors of Folclande, and together with the bishop administered the oath of allegiance to the freemen, over whom he presided when they sat in their judicial capacity, and whose decrees it was his duty to enforce."

Mr. Allen, in his 'Inquiry into the Rise and Growth of the Royal Prerogative in England, 8vo. Lond., 1830, goes more at length into this subject: he says that Bocland might belong to the church, to the king, or to a subject. It might be alienable and devisable at the will of the proprietor. It might be limited in its descent, without any power of alienation in the possessor. It was often granted for a single life or for more lives than one, with remainder in perpetuity to the church. It was forfeited for various delinquencies to the state. Bocland, moreover, was released from all services to the public, except those which were comprised in the phrase "trinoda necessitas," which were said to be incumbent on all persons: these were the contributing to military expeditions, and to the reparation of castles and bridges. Bocland also might be held by freemen of all ranks and degrees. A ceorl might possess bocland and perform for it military service to the state. If he had five hides of bocland, with the other requisites demanded by law, he was entitled to the privileges of a Thegn. (Wilkin's 'Leg. Anglo-Sax.' pp. 70, 71.) Gesiths (companions or partners) might receive grants of bocland. (Hickes, 'Gramm. Anglo-Sax.' p. 139; Bedæ, 'Hist. Eccl.' cura Smith, p. 786.) Thegns might also possess bocland. But the estate of a thegn in bocland must not be confounded with the thegn-lands which he held, by a beneficiary tenure from the king or from a private lord, for military service. Thegn-lands held of the king or state are repeatedly mentioned in Domesday; and the Saxon laws carefully distinguish the bocland possessed by a thegn, from the land given him by his hlaford (or lord). ('Leg. Can.' p. 75.) It is probable that thegn-lands were originally granted for life, as beneficiary lands were on the Continent; but before the end of the Saxon period, the possessions given to a man by his hlaford descended in certain cases to his children. (Ibid.) The estates of the higher nobility consisted chiefly of bocland. Bishops and abbots might have bocland of their own, in addition to what they held in right of the church. The Anglo-Saxon kings had private estates of bocland; and these estates did not merge in the crown, but were devisable by will, alienable by gift, or sale, and transmissible by inheritance in the same manner as bocland held by a subject.

When bocland was created, it was released from the burthens to which folcland was subjected, and the proprietor, unless fettered by the original grant, or by a subsequent settlement of the estate, appears to have had an unlimited power to dispose of it as he chose (Somner's 'Gavelkynd'); in the exercise of that power he might transfer it by grant or bequeath it by will, in such quantities, for such periods, and on such conditions as he was pleased to appoint. If conveyed by a written instrument, whatever might be the stipulations annexed to the grant, the land was still denominated bocland. (See Heming's 'Chartul.' and Smith's 'Bede.') When once severed from the folcland, or property of the community, an estate retained the name of bocland, whatever were the burthens and services imposed on it, provided it was alienated by deed. When transferred on condition of reversion, it seems to have been called *lænland*. This appears from a transaction recorded in the Chartulary of Worcester. (Heming, p. 158; see also *ibid.* pp. 204, 205.) We are there told that Archbishop Oswald granted to Ælfsige a tenement in Worcester, with the croft attached to it, for three lives, to be held as amply in the form of bocland as it had been held before in the form of lænland. Lænland might be an estate for life, or it might be held at will; and if the possessor was convicted of felony it reverted to the donor. (Lappenberg and Kemble.)

Bocland, says Mr. Allen, when alienated by grant or will, might be free, or in the seignory of some church, manor, or individual. It might be subjected to a variety of conditions, but it must be conveyed by a written instrument, though the delivery was symbolised by a staff, an arrow, a drinking horn, &c.; and a great part of the charters in the 'Codex Diplomaticus Ævi Saxonicum' relate to the changing of folcland into bocland. Tenants of bocland might be persons of the same description with the lowest and most dependent of the occupiers of folcland. The only difference between them seems to have been, that the tenants of folcland held their lands directly from the public authorities of the state, while the others held their land of some proprietor, to whom it had been previously granted as a private inheritance. The villain of later times and the copyholder of the present day are not derived from the one more than from the other.

Bocland might be forfeited for various offences, and when forfeited, it escheated to the king, as the representative of the state. ('Leges Æthelredi Regis,' 2; 'Leg. Cnuti,' 12, 75; 'Text. Roff.,' pp. 44, 136; Hickes, 'Diss. Ep.) Land held of a subject, when forfeited for the same delinquency, escheated to the lord. ('Leg. Cnuti.') When bocland was granted on lives, it was usual to insert a clause in the charter, declaring that whatever offence the tenant might commit, his land should revert without forfeiture to the grantor. ('Monasticon Angl.,' vol. iii.)

From the view that has been taken of the distinction between folcland and bocland, it follows that the folcland, or land of the community, like the fisc of the Continental nations, was the fund out of which the boclands, possessions or estates of inheritance, were carved. At what time the folcland, or land of the public, began to be converted into bocland we are not informed. It was probably soon after the establishment of the Saxons in England; for though a more rude and uncultivated people than the nations which had enjoyed greater opportunities of intercourse with the Romans, they must have found private property in land among the Britons whom they expelled or subdued, and could not long remain insensible to the advantages arising from it. Certain it is, that in one of the earliest charters giving land to the Church, it is implied, though not expressly asserted in the grant, that the land contained in the donation had been previously the private property of the donor. (Between A.D. 665 and 694, see Smith's 'Bede,' p. 748.) But though commenced at an early period, the conversion of folcland into bocland seems to have been slowly and gradually effected. Every charter creating bocland is a proof that the land had formerly been folcland. A charter of Archbishop Wilfred, who died about 830, asserts in direct terms, that the land which he gives away had never been any man's bocland before it became his, and appeals to general practice, whether a proprietor of bocland might not sell it or dispose of it as he pleased. (Somner's 'Gavelkynd.')

Folcland being the property of the community, could not be converted into bocland except by an act of government. In early times this was probably done in the gemot or public assembly of the tribe, as temporary allotments to individuals were made in the gemot or assembly of the district. But when the king came to be considered as the representative of the state, all charters of bocland ran in his name, and appeared to emanate from his bounty. The power of creating allodial property, by which was meant an estate of inheritance, is enumerated in the 'Textus Roffensis,' cap. xxvii., among the prerogatives of the crown. But though bocland could not be created without the authority of the king, it was not in his power to convert folcland into bocland without the consent of his witan, principes, seniores, optimates, magnates, or other persons, by whatever name they were called, who assisted him in the administration of his kingdom. There is hardly a Saxon charter creating bocland which is not said to have been granted by the king with consent and leave of his nobles and great men. If that consent was withheld, his grant was invalid.

When the king became the representative of the state, the folcland, or land of the public, began to be called and considered his property. It was his land in the same sense that the servants of the public were his servants, the laws his laws, and the army his army. In his politic capacity he was the state, and whatever belonged to the state belonged to him. If folcland was assigned to any one for life, or for a shorter term, it was given by his authority, and apparently for his service. When it was converted by charter into bocland, or land of inheritance, the deed was executed in his name, and though the grant was of no validity without the concurrence of his witan, the donation seemed in form the spontaneous act of his munificence.

In fact, there seems but little doubt that the folcland of our Saxon ancestors, which, in contradistinction to bocland, has so long puzzled English antiquaries, was no other than the public land, which in the lapse of time ultimately received another appellation, that of Terra Regis, or crown land. The term Bocland, as has been already noticed, was appropriated to such portions as from time to time had been severed from it, and granted out by written instrument. These severances increased rapidly towards the close of the Anglo-Saxon period. Mr. Kemble says, "I should imagine nearly every acre of land in England had become bocland." As in many cases, particularly in grants to the Church, even the usual burthens for military defence were remitted, it evidently enfeebled the nation, and in some degree accounts for the successes of the Danes and Normans in their invasions.

It is remarkable that in the Domesday Survey the term Bocheland occurs but once in its proper acceptation ('Domesd.' tom. i. fol. 11 b.): though as the name of a place it frequently occurs. (See Ellis's 'General Introd. to Domesd. Book,' vol. i. p. 230, note.) Mr. Allen, 'Inquiry, &c.,' observes that numerous entries in Domesday distinguish lands which in Saxon times must have been bocland into free lands and lands in seignory. (See 'Domesd.,' tom. i. fol. 72 a, col. 2, 80a, col. 1, 84 b, col. 2, &c.)

BODLEYAN, or BODLEIAN LIBRARY. The public library of the University of Oxford was founded in 1597 by Sir Thomas Bodley, in the year in which he retired altogether from public employment [BODLEY, SIR THOMAS, in BIOG. DIV.]

The first public library in Oxford was established in what was then called Durham (since Trinity) College, by Richard de Bury, or Aungerville, bishop of Durham and lord treasurer of England, in the time of Edward III. He died in 1345, and left his books to the students of Durham College, who preserved them in chests, until the time that Thomas de Hatfield, his successor in the see of Durham, built the library in 1370. Chalmers, however, in his 'History of the Colleges, Halls, and Public Buildings of Oxford,' vol. ii. p. 458, says, it is not

very clear whether this was a public library in the usual meaning of the term, or one restricted to the use of the monks of Durham College only.

The next we read of was called Cobham's Library, which would have been the first, if Thomas Cobham, bishop of Worcester, had lived to have executed his own purpose. About the year 1320, he began to make some preparations for a library over the old Congregation-House, in the North Churchyard of St. Mary's; but dying soon after, little progress was made in the work till 1367, when his books were deposited in it, and the scholars permitted to consult them on certain conditions. But the property of the site being contended between the University and Oriel College, the dispute was not finally determined till 1409, when the room was fitted up with desks, windows, &c., by the benefactions of King Henry IV., of his four sons, Henry, Thomas, John, and Humphrey, of Thomas Arundel archbishop of Canterbury, Philip Repindon bishop of Lincoln, Edmund earl of March, and Richard Courtney chancellor of the University, in whose time it was completed about the year 1411. This appears to have been the first public library, and continued in use until 1480, when the books were added to Duke Humphrey's collection, for the reception of which a library-room had been completed.

Humphrey, surnamed the Good Duke of Gloucester, was the real founder of the library which was restored and refounded by Sir Thomas Bodley. The number of books given by Duke Humphrey is variously represented. Wood ('Hist. and Antiq. of the Univ. of Oxford,' vol. ii. pt. ii. 4to, Oxf. 1796, p. 715) says the different treatises amounted to six hundred; only one specimen at present remains, a manuscript in folio of Valerius Maximus, enriched with the most elegant decorations, and written in Duke Humphrey's age, evidently with the design of being placed in his sumptuous collection. The rest of the books, which, like this, being highly ornamented, and looking like missals, were supposed to convey ideas of Popish superstition, were destroyed or removed by the visitors of the university in the time of Edward VI., whose zeal was equalled only by their ignorance. A manuscript commentary on Genesis, by John Capgrave, belonging to Duke Humphrey's library, is still preserved in that of Oriel College, Oxford; and one, if not more manuscripts, formerly belonging to the collection, are in the British Museum; most of them, at the end, had usually this inscription written in the duke's own hand, "C'est livre est a moy Humfrey Duc de Gloucestre." Before the year 1555 the Duke of Gloucester's Library was totally despoiled of its contents, and the desks and benches ordered to be sold: the room continued empty until restored by Sir Thomas Bodley.

It was in 1597 that Sir Thomas Bodley set himself the task of restoring the public library. With this view he sent a letter from London to the vice-chancellor Dr. Ravis, dean of Christ Church, offering to restore the building, and settle a fund for the purchase of books, as well as the maintenance of proper officers. This offer being gladly accepted, he commenced his undertaking by presenting a large collection of books purchased on the Continent, and valued at 10,000*l*. Other collections and contributions were sent in, by his example and persuasions, from various noblemen, clergymen, and others, to such an amount, that the old building was no longer sufficient to contain them. He then proposed to enlarge the building; and the first stone of the new foundation was laid with great solemnity on the 17th of July, 1610, and so amply promoted by his liberality, as well as by the benefactions of many eminent persons, that the University was enabled to add three other sides, forming the quadrangle and rooms for the schools, &c. Bodley did not however live to see even the wing he had commenced finished, having died in 1612, the year before its completion.

When Sir Thomas had succeeded in enriching his collection, probably far beyond his expectation, he drew up a body of statutes, which have been since incorporated with those of the university. According to them, the librarian is to be a graduate, unmarried, and without cure of souls; and to be allowed deputies or assistants. One or two points in these regulations have been since altered; the librarian is allowed to marry, and he can hold parochial preferment with his librarianship. The revenues for the maintenance of the library are intrusted to the vice-chancellor and proctors for the time being; and the vice-chancellor and proctors, the three professors of divinity, law, and physic, and the two regius professors of Greek and Hebrew, are appointed visitors.

The first catalogue of the printed books of the Bodleian was published in 4to, in 1605, by Dr. Thomas James, Sir Thomas Bodley's first librarian. It was dedicated to Henry Prince of Wales; and the books were classed in four faculties, divinity, medicine, jurisprudence, and arts, completed by an index of authors' names. A more extensive catalogue, in an alphabetical form, was published by Dr. James in 4to, Oxford, 1625; and another catalogue, which had been compiled by him, of works in the Bodleian, printed and manuscript, in interpretation of the Scriptures, was printed in a thin 4to at Oxford in 1635. 'A Nomenclator of such Tracts and Sermons as have been printed or translated into English upon any place or books of Holy Scripture; now to be had in the most famous Library of Sir Thomas Bodley in Oxford,' was also printed in 18mo in 1642, by John Veneuil.

In 1674 a new catalogue of the printed books of the Bodleian was published in a folio volume, under the care of Dr. Thomas Hyde;

and another, of the manuscripts, distinguishing the different collections, was inserted in the general Catalogue of the Manuscripts of England, folio, 1697. A still more extensive catalogue of the printed books was published in two volumes, folio, in 1738, which was thought so sufficiently perfect in its day, that almost every college library in the university had a copy interleaved, to mark off the books in the catalogue which they themselves possessed, and to insert additions. This is the last general catalogue which has been published of the books in the Bodleian Library; but from the immense increase of the collection it has become but of little use. Another was undertaken some years ago, and had proceeded, under the direction of the present librarian, Dr. Bandinel, to some extent in the printing; but the publication was eventually abandoned.

A few catalogues of particular portions of the Bodleian collections have been published at different times. Dr. Uri printed the first part of a catalogue of the Oriental manuscripts in folio, in 1787; which was continued in 1821, in a catalogue of the Arabic manuscripts, prepared by Mr., afterwards Dr. Alexander Nicol. After the acquisitions made at the Pinelli and some other sales, a small octavo volume, entitled 'Notitia Editionum quoad libros Hebr. Gr. et Lat. quæ vel primariæ, vel Sæc. xv. impressæ, vel Aldinæ, in Bibliotheca Bodleiana adservantur,' was published in 1795: another catalogue, entitled 'Codices Manuscripti et Impressi, cum Notis Manuscriptis, olim D'Orvilliani, qui in Bibliotheca Bodleiana adservantur,' was printed by Mr. Gaisford, afterwards dean of Christ Church, in 4to, 1806; and the first part of another catalogue, of the manuscripts collected in the East by Dr. E. D. Clarke, and purchased from him for the Bodleian, was published also by Mr. Gaisford in 4to, 1812; followed by a second part in 1815, containing the Oriental MSS., edited by Mr. Nicol. In 1814, a catalogue of the books relating to British (including Welsh, Scottish, and Irish) topography, and Saxon and northern literature, bequeathed by Richard Gough, Esq., was printed at the Clarendon press by Dr. Bandinel. The curators of the Bodleian have for many years published, or rather printed and distributed, annual alphabetical catalogues of its acquisitions in the department of printed books, for the information of the university.

A catalogue of the coins in the cabinet of the Bodleian was published by Mr. Francis Wise in 1750, in folio, illustrated by numerous plates, under the title of 'Catalogus Nummorum Antiquorum in Scriniis Bodleianis reconditorum cum Commentario.'

An annual speech in praise of Sir Thomas Bodley was founded in 1681, by Dr. John Morris, canon of Christ Church; the speaker to be nominated by the dean of Christ Church, and confirmed by the vice-chancellor. These speeches are delivered at the visitation-day of the library, November the 8th.

It would be impossible to enumerate here the many important additions, in books and manuscripts, made to this library by its numerous benefactors, or to give even a superficial sketch of its ample contents in every branch of science and learning. Among the earliest benefactors were Robert Devereux Earl of Essex, Thomas Sackville Lord Buckhurst and Earl of Dorset, Robert Sidney Lord Sidney of Penshurst, Viscount Lisle and Earl of Leicester, George Carey Lord Hunsdon, William Gent, Esq., Anthony Browne Viscount Montacute, John Lord Lumley, Philip Scudamore of London, Esq., and Lawrence Bodley, younger brother to the founder. The contributions of all these persons were made before the year 1600.

In 1601, collections of books and manuscripts were presented by Thomas Allen, some time fellow of Trinity College, Thomas James, the first librarian, Herbert Westphaling, bishop of Hereford, Sir John Fortescue, knight, Alexander Nowell, dean of St. Paul's, John Crooke, recorder of London and chief-justice of the Common Pleas, and Nicholas Bond, D.D., president of Magdalen College.

The most extensive and important collections however are those of the Earl of Pembroke, the celebrated John Selden, Archbishop Laud, Sir Thomas Roe, Sir Kenelm Digby, General Fairfax, Dr. Marshall, Dr. Barlow, bishop of Lincoln, Dr. Richard Rawlinson, Mr. St. Amand, Bishop Tanner, Browne Willis, Thomas Hearne, Mr. Nathaniel Crynes, and Mr. Godwin. The library bequeathed by Richard Gough, Esq., which came to the Bodleian in 1812 (the catalogue of which has been already noticed), is one of the most perfect series of English topographical works ever formed, and is particularly rich in topographical manuscripts, prints, drawings, and books illustrated by the manuscript notes of eminent antiquaries. The last collections of great importance bequeathed to the Bodleian have been those of Edmond Malone, Esq., in 1812, and of Francis Douce, Esq., in 1834, but it is continually being added to by smaller bequests and donations.

The Bodleian Library was first opened to the public on November 8th, 1602, and by the charter of mortmain obtained of King James, Sir Thomas, then lately knighted by him, was declared founder; and, in 1605, Lord Buckhurst, earl of Dorset and chancellor of the University, placed the bust of Sir Thomas in the library. Since the year 1786 a fund of more than 400*l*. a year has been established for the purchase of books. This arises from a small addition to the matriculation fees, and a moderate contribution annually from such members of the university as are admitted to the use of the library, or on their taking their first degrees; to which is to be added the privilege of claiming as a matter of right under the copyright act, a copy of every book printed in Great Britain and Ireland.

The principal librarians since the foundation by Sir Thomas Bodley, have been,—1. Thomas James, fellow of New College, 1598; 2. John Rouse, fellow of Oriel, 1620; 3. Thomas Barlow, fellow, afterwards provost of Queen's, bishop of Lincoln, 1653; 4. Thomas Lockey, student, and afterwards canon of Christ Church, 1660; 5. Thomas Hyde, of Queen's College, afterwards Laudian professor of Arabic, regius professor of Hebrew, and canon of Christ Church, 1665; 6. John Hudson, of Queen's, afterwards principal of St. Mary Hall, 1701; 7. Joseph Bowles, fellow of Oriel, 1719; 8. Robert Fysher, fellow of Oriel, 1726; 9. Humphrey Owen, fellow and afterwards principal of Jesus College, 1747; 10. John Price, B.D., of Jesus College, afterwards of Trinity, 1768; 11. Bulkeley Bandinel, D.D., late fellow of New College, 1813, the present librarian.

All members of the university who have taken a degree are admitted to study in the library: no books have ever been suffered to be taken from it. Literary persons, either native or foreign, are also allowed, on being properly recommended, to read and take extracts from the books in this collection. The library is open between Lady-day and Michaelmas from nine in the morning till four in the afternoon; and during the other half-year from ten till three. It is closed on Sundays and state holidays; from Christmas-eve to the 1st of January inclusively; on the feast of the Epiphany; from Good Friday to Easter Tuesday inclusively; on the days of Encænia and Commemoration; seven days immediately following the 1st of September, and eight days preceding the visitation of the library, which takes place on the 1st of November. On all other holidays it is opened immediately after the university-sermon.

(*Reliquiæ Bodleianæ*, 8vo. London, 1703; Wood's Account of Bodley's Library, *Hist. and Antiq. of the University of Oxford*, 4to. 1796, vol. ii. P. ii. pp. 920-953; Chalmers's *History of the Colleges, Halls, and Public Buildings attached to the University of Oxford*, vol. ii. pp. 458-464; *Oxford University and City Guide*, 8vo.; Parker's *Hand-Book for Oxford*; and the *Oxford University Calendar*.)

BOHEIC ACID. An astringent acid said to be contained in black tea. Its existence is, however, very doubtful.

BOHEMIANS. [Gipsies.]

BOIL, called also phlegmon and furunculus, from *furo*, to rage, on account of the violence of the heat and inflammation attending it. A boil is a tumour of an inflammatory nature seated in the skin and in the cellular tissue beneath it. It may occur on any part of the external surface of the body, and it is of various sizes from the bulk of a pea to that of a pigeon's egg, which latter it seldom exceeds. The tumour is circumscribed, prominent, hard, of a conical figure, the base of the cone being broad, deep, and intensely red. The whole surface of the tumour is exquisitely tender, and is commonly attended with a very painful sense of burning and throbbing. Its natural termination is in suppuration, that is, in the formation of the matter called pus, but the progress is always slow and the process itself imperfect, the pus formed being generally scanty and never healthy. Only a few drops of purulent matter, commonly mixed with blood, flow from the most prominent or pointed part of the tumour, while there remains behind the germ, or what is commonly called the *core*, a purulent sloughy substance, so thick and tenacious that it appears like a solid body. When this core is discharged, the pain entirely ceases and the opening heals spontaneously, but the removal of this is indispensable to the cure of the disease.

The complaint is never attended with danger, and seldom accompanied with fever, excepting when the tumour is seated over some peculiarly sensitive part, or when (as occasionally happens) several tumours occur at the same time in several places. Under such circumstances, in adults of irritable habits, and almost always in children, a good deal of constitutional disturbance is excited.

The disease, though local in its seat, is constitutional in its origin, and affords a good example of a class of maladies, a very large one, which are limited in their seat to a small spot, perhaps on the external surface of the body, but which have their source in the disturbance of some internal organ or of the system in general.

The internal organs, the derangement of which most commonly produces this external disease, are those which belong either to the digestive or to the excrementitious systems, or to both. In consequence of the disordered state of these organs, either perfectly pure chyle is not eliminated, or the blood is not properly depurated, or excrementitious matter is re-absorbed into it, the circulating fluids become contaminated, and the result is the irritation and inflammation of the surface.

The rational and successful treatment of this disease must therefore combine two objects,—the removal of the local malady, and the correction of the disordered state of the system in which it has its origin. The first intention is accomplished by assisting the process of suppuration, which, as already stated, is always tardy and imperfect, but must be rendered complete before the malady can be removed. The proper external applications are repeated emollient poultices, as those made of linseed meal, which may be mixed, when the pain is violent, with conium, hyoscyamus, or opium. The suppuration is so imperfect that even the diligent use of poultices seldom causes the tumour to burst spontaneously with an aperture sufficiently large to allow of the discharge of the pus, together with the sloughy cellular substance that forms the core. As soon as any matter can be perceived in the tumour a free opening should therefore be made into it with a lancet, and as much of the matter and slough as can be forced out of it by tolerably firm pressure should be removed.

While recourse is had to these external applications, it is indispensable to correct the disordered state of the organs. This may be effected by a course of mild alterative medicines: the bowels should always be freely opened at first, and then *regulated* by gentle unirritating laxatives. At the same time strict attention should be paid to the diet, which should be of the plainest and simplest nature, nutritive but not stimulating, consisting of a moderate portion of plainly cooked animal food, without fermented liquors, without pastry, and without fruit.

BOILER is the general name applied to vessels, whether close or open, in which fluids are exposed to heat for the purpose of ebullition or evaporation; but the term is most commonly applied to the close vessels used for the generation of steam. Such boilers, to lessen the danger of explosion, are almost invariably made of wrought metal, which, if burst, will tear rather than fly to pieces, as cast metal would do; and the plates made for the purpose are formed of the best and toughest metal, and rolled or wrought with peculiar care. Engineers differ as to the comparative merits of iron and copper as a material for steam-engine boilers. Most however admit that iron, when of good quality, has the greatest cohesive strength, although the greater uniformity of texture in sheet-copper renders it safe to construct copper boilers of less thickness than those of iron, to withstand a given pressure. Further than this, supposing an explosion to occur with a copper boiler, it is likely only to produce a rent or tear in the metal, while an iron boiler, even though wholly of wrought plates, is frequently blown to pieces. The cost of copper is about four times that of iron, but as, owing to its far more rapid transmission of heat, a copper boiler may be made considerably smaller than an iron one to produce the same quantity of steam, and may therefore be still further reduced in thickness and weight without impairing its strength; the cost of a copper boiler is nearer twice than four times that of an iron boiler of equal evaporating power; and, as a set-off to this increased expenditure, the value of the old copper, when the boiler is worn out, is equal to three-fourths of its original cost, while an old iron boiler is worth little more than the cost of removal.

The various kinds of boiler employed in manufacturing operations will be treated of under the heads of the different purposes for which they are employed; as Steam-Engine, Steam-Carriage, Steam-Vessel, Sugar Boiling, Warming and Ventilation, &c.

BOILING OF LIQUIDS. A liquid is said to boil when bubbles of the vapour of the liquid are formed, and, by reason of their lightness, rise to its surface and escape. The circumstances conditioning the formation of such bubbles are four:—1. The nature of the liquid in respect to chemical constitution. 2. The temperature to which it is exposed. 3. The pressure upon its surface, and consequently throughout its mass. 4. The magnitude of the force of adhesion between the liquid and the substance with which it is in contact.

An example will illustrate this. A glass basin containing boiled distilled water may be gradually heated to 216° Fahr. without the water boiling. We have then the four above-named conditions in the following state:—

1. Oxygen and hydrogen, in the proportion of 8 to 1 (HO).
2. A temperature of 216° Fahr.
3. The existing pressure of the atmosphere (say 15 lbs. per square inch).
4. The adhesion between water and glass.

By altering any one of these conditions, boiling or ebullition may be produced. Thus: 1, if ether, $(C_4H_5O)_2$, be substituted for water, the ether will boil; 2 if, the temperature be raised a few degrees the water will boil; 3, if, the basin being put under the air-pump, the air be exhausted, the pressure of the atmosphere being thereby diminished, the water will boil; 4, if the glass basin be replaced by a copper one, the water will boil.

Again, respecting the above-mentioned four conditions: 1, two or more chemically dissimilar liquids may boil at the same temperature, under the same pressure, and in the same vessels; 2, one and the same liquid cannot boil at two different temperatures under the same pressure and in the same vessel; 3, one and the same liquid cannot boil at the same temperature under two different pressures in the same vessel; 4, it is probable, although not certain, that one and the same liquid cannot boil at the same temperature and under the same pressure in two vessels whose internal surfaces so differ in texture or constitution as to possess different adhesion to the liquid. But as both physical texture and chemical constitution affect the boiling of a liquid independently, it follows that the same liquid may boil at the same temperature and under the same pressure in vessels of unlike chemical constitution, provided that their surfaces are so unlike in texture also as to counterbalance their chemical dissimilarity. Thus, water boils at a lower temperature in metallic vessels than in glass ones. It boils also in vessels whose internal surfaces are rough at a lower temperature than in smooth ones. Hence, in a smooth metallic vessel it may boil at the same temperature and under the same pressure as it does in a rough glass one.

We must examine one by one the above-mentioned four circumstances which determine the boiling of a liquid, bearing in mind that

ebullition is *affected* by the chemical nature of the liquid (but the law according to which such chemical constitution is connected with the boiling has been established in only a comparatively few cases), and that it is *induced* by increase of temperature, diminution of pressure, and diminution of adhesion between the boiling liquid and the substance with which it is in contact.

A liquid is said to be perfectly volatile when it can be boiled away without chemical change. If heat be applied to a vessel containing a single such volatile liquid, its temperature will gradually rise until it reaches a certain point (dependent upon the four conditions) at which boiling commences; that is, at which the pressure of the air is overcome by the expansive force of the vapour of the liquid. If the heat be continually applied after this point is reached, the liquid is boiled off in the form of vapour, but to the last it retains the same temperature as that at which it commenced boiling,—a temperature which the vapour of the liquid also assumes. After the boiling has once commenced the external heat is expended, not in effecting a rise of temperature, but in converting the liquid into a vapour. Hence, the temperature at which one and the same volatile liquid boils is constant (the other two conditions being also constant), and that temperature is called the *boiling point* of the liquid under those conditions.

A liquid which is boiled in an open vessel is exposed to the pressure of the atmosphere, and its boiling is induced or retarded according as this pressure is less or greater. Thus, when the atmospheric pressure is small [BAROMETER], water boils at a lower temperature and in a smoother vessel than when it is great. Hence, in determining the temperature at which a liquid boils in an open vessel of fixed nature, reference must be had to the existing atmospheric pressure. Conversely, from the temperature at which a simple volatile liquid boils in an open vessel of fixed nature, the atmospheric pressure may be determined.

It follows from the above, that if exact comparison has to be made of the temperatures at which chemically different liquids boil, the determinations must be made when the liquids are subjected to the same atmospheric pressure, or the effect of change of pressure on the boiling point must be ascertained, and the corresponding correction made.

In the following table are found the boiling points of various liquids in contact with platinum wire, at the mean barometric pressure of 29·92 inches (760 millimètres). The temperatures are given on the Fahrenheit scale.

Substance.	Chemical Composition.	Boiling Point.
Protoxide of nitrogen	NO	— 157
Carbonic acid	CO_2	— 108
Cyanogen	C_2N	— 7
Sulphurous acid	SO_2	+ 12
Chloride of ethyl	C_4H_5Cl	+ 52
Ether	$(C_4H_5O)_2$	92
Formate of methyl	$C_2H_3OC_2HO_3$	97
Bisulphide of carbon	CS_2	117
Acetate of methyl	$C_2H_3OC_4H_3O_3$	131
Formate of ethyl	$C_4H_5OC_2HO_3$	131
Methylic alcohol	C_2H_3OHO	138
Propionate of methyl	$C_2H_3OC_6H_5O_3$	167
Acetate of ethyl	$C_4H_5OC_4H_3O_3$	167
Formate of propyl	$C_6H_7OC_2HO_3$	167
Ethylic alcohol	C_4H_5OHO	172
Benzol	$C_{12}H_5H$	176
Butyrate of methyl	$C_2H_3OC_8H_7O_3$	199
Propionate of ethyl	$C_4H_5OC_6H_5O_3$	199
Acetate of propyl	$C_6H_7OC_4H_3O_3$	199
Formate of butyl	$C_8H_9OC_2HO_3$	199
Propylic alcohol	C_6H_7OHO	207
Formic acid	C_2HO_3HO	210
Water	HO	212
Toluol	$C_{14}H_7H$	219
Butylic alcohol	C_8H_9OHO	241
Acetic acid	$C_4H_3O_3HO$	244
Xylol	$C_{16}H_9H$	262
Bibromide of ethylene	$C_4H_4Br_2$	266
Amylic alcohol	$C_{10}H_{11}OHO$	275
Propionic acid	$C_6H_5O_3HO$	279
Bibromide of propylene	$C_6H_6Br_2$	293
Cumol	$C_{18}H_{11}H$	306
Butyric acid	$C_8H_7O_3HO$	311
Oil of turpentine	$C_{20}H_{15}H$	315
Bibromide of butylene	$C_8H_8Br_2$	320
Valerianic acid	$C_{10}H_9O_3HO$	347
Cymol	$C_{20}H_{13}H$	349
Sulphur	S	608
Sulphuric acid	SO_3HO	619
Mercury	Hg	680

An examination of this table points out the existence of a certain relation between the chemical constitution of some liquids and their boiling points at the same pressure. When two liquids, belonging to the same chemical type, so differ from one another that the one contains a molecule more of C_2H_2 than the other, the boiling point of the first is often 34°·2 Fahr. above that of the second. Thus the boiling points of formic, acetic, propionic, butyric, and valerianic acids increase by the successive increment of 34°·2 Fahr., as do those of

their corresponding alcohols, namely, methylic, ethylic, propylic, butylic, and amylic. Moreover the compounds resulting from the union of the above acids with the radicals of the various alcohols follow the same law. For not only are the boiling points of butyrate of methyl, propionate of ethyl, acetate of propyl, and formate of butyl, the same (the increase of 34°·2 Fahr. due to the additional C_2H_2 in the radical being exactly counterbalanced by the removal of C_2H_2 from the acid), but the bodies just named boil 34°·2 higher than propionate of methyl, acetate of ethyl, and formate of propyl: which again boil 34°·2 higher than acetate of methyl and formate of ethyl; while these latter boil 34°·2 above formate of methyl.

In the benzol series, however, this increment of C_2H_2 effects an elevation of 43°·2, while in the bromethylene series the increase is only 27°.

When an alcohol is converted into an acid by the exchange of two equivalents of hydrogen for two of oxygen, the boiling point is thereby raised 72°.

The above are the most perfectly developed of Kopp's laws relating to the connection between boiling point and chemical constitution. Although bodies belonging to the same chemical series have boiling points higher or lower according to their position in that series, yet liquids belonging to different series may have boiling points which, as far as experiment shows, perfectly coincide.

There appears to be no relation between the specific gravity of a liquid and its boiling point.

The chemically combined water in a liquid seems to have great influence upon its boiling point. This may be connected with the high latent heat of steam. Thus those alcohols whose boiling points are below 212° (ethylic) furnish, by the loss of water, ethers whose boiling points are still lower; while an alcohol which boils above 212° gives rise to an ether of higher boiling point than itself (amylic alcohol).

The following tables show the relation between the boiling points of various bodies and the pressures to which they are subjected: in other words they give the tension of the vapours of the bodies at different temperatures. (From Buff, Zamminer, and Kopp's 'Lehrbuch der physikalischen und theoretischen Chemie.') t° denotes the temperature Fahrenheit of the substance, and h the height of the column of mercury, in inches, which the vapour will support.

I. FOR WATER. (Regnault.)

t°	h	t°	h
— 26	0·0126	+ 122	3·6213
— 4	0·0365	140	5·8579
+ 14	0·0824	158	9·1768
32	0·1811	176	13·962
50	0·3608	194	20·687
68	0·6847	212	29·921
86	1·2420	302	140·993
104	2·1614	392	460·194

II.

t°	For Alcohol. h	For Ether. h	For Bisulphide of Carbon. h
+ 14	·2559	4·4567	3·1102
32	·5012	6·9771	5·0118
50	·9480	11·2795	7·8464
68	1·7323	17·1180	11·7401
86	3·0866	25·0787	17·1102
104	5·2795	33·9884	24·3110
122	8·6732	49·9212	33·5708
140	13·7795	68·1219	43·7716
158	21·2283	90·9250	60·9841
176	31·9999	116·0313	79·9407
194	46·8660	153·5036	103·2714
212	66·3384	193·7161	130·7596

Formulæ have been proposed to correct the pressure and the boiling point, and thus to serve to derive new values by interpolation. But all such formulæ are more or less empirical, and cannot be relied on when the values sought are far from actually observed ones.

Contact with foreign bodies, as before stated, influences the boiling point of a liquid to some extent. Hence in comparing the boiling points of liquids, the latter must all be in contact with the same substance, generally platinum wire. When two liquids are perfectly miscible, the initial boiling point of their mixture is always above that of the liquid which has the lowest boiling point, and during the boiling it rises (more or less suddenly, according as the respective boiling points of the separate liquids are further apart or nearer), until the higher boiling point is reached, or nearly reached. But in a volatile liquid which, though not miscible with—still may be wetted by—water, the presence of water depresses the boiling point of the liquid, although the latter when dry would boil below 212° Fahr. This effect is probably due to the small quantity of disseminated water diminishing the cohesion of the liquid.

It is found that when two substances affect the boiling point of a liquid unequally, and both are present in it, the liquid will boil at the temperature due to the substance which depresses its boiling point most. Hence, in practice, in determining the boiling point of liquids,

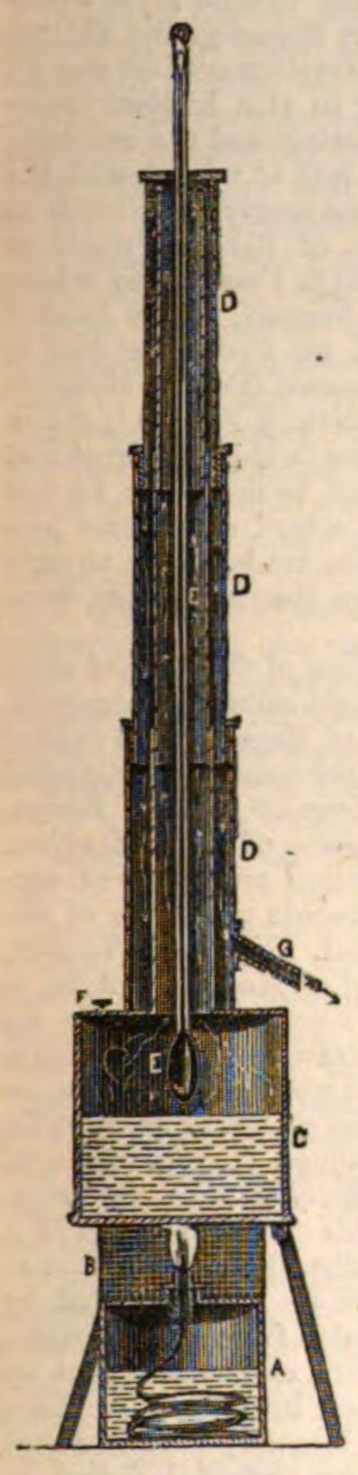
instead of employing platinum vessels it is sufficient to introduce a piece of platinum into the liquid which is in a glass vessel.

On ascending mountains, by the consequent diminution of atmospheric pressure, and in proportion to it, water is found to boil at a lower temperature. Thus, on the summit of Mont Blanc, which is 15,650 feet above the level of the sea, Saussure found water to boil at 185°·8 of Fahrenheit. M. Wisse has recently determined the boiling point on Mount Pichincha, at an altitude of 15,940 feet, to be 185°·27 Fahr., whilst the barometer stood at 17·208 inches.

The effect of diminished pressure in lowering the boiling point may be readily exhibited: remove some boiling water from the fire, and ebullition soon ceases, but it is renewed by placing it under the receiver of an air-pump and quickly exhausting the air. Another and very simple method of producing the same effect is, to boil some water in a Florence flask, cork it while boiling, remove it immediately from the fire, and immerse it almost entirely in cold water, when the ebullition will recommence. This is occasioned by the sudden condensation of the steam which occupied the upper part of the flask, and the consequent formation of a vacuum; the existence of which is proved by the rush of air into the flask on removing the cork.

According to the Rev. Mr. Wollaston ('Phil. Trans.,' 1817), an elevation of 530 feet causes a diminution of 1° of Fahrenheit in the temperature of boiling water; but it will be observed that this determination, which is probably an accurate one, does not agree with the stated height of Mont Blanc, or the temperature at which water boils on its summit.

The Rev. Mr. Wollaston contrived an apparatus for determining elevations by the temperature of boiling water. It has been improved and introduced under the name of the *Barometrical Thermometer*, made by Negretti and Zambra, to meet the requirements of travellers under circumstances where the mercurial barometer cannot be conveniently employed. The instrument is very portable, and consists of a very delicate thermometer, about 12 inches long, with a scale ranging from 180° to 212°, each degree being subdivided so as to show distinctly 0°·1. There is also a copper boiler C attached to a small tripod stand; from the top of the boiler proceeds a three-draw telescopic tube, open at the top; this tube is surrounded by a second, similarly constructed, and screwed at the top of the boiler; the outer tube has two openings, one at the top through which the thermometer is inserted, passing down to within an inch of the water in the boiler, and supported by means of a cork or India-rubber washer; the second opening, forming an outlet for the steam, is shown at G. The object of the double tube is to ensure a steady boiling-point, which cannot well be obtained in open air experiments, where only a single tube is employed. A is a metallic spirit-lamp, surrounded with wire-gauze, to prevent the flame from being extinguished when experimenting in the open air. Each instrument is furnished with a carefully computed set of tables, from which may be obtained, by an easy calculation, the elevation corresponding to any observed boiling-point, between the temperatures of 180° and 212°. In using the apparatus, a sufficient quantity of water is poured into the boiler, through the small opening F, to fill it about one-third, when it is closed by means of a screw; the spirit-lamp is then applied, and when the water boils, the steam rises, surrounds the bulb and tube, descends between the two tubes, and issues from the opening at G. After a few seconds the mercury in the thermometer will rise and become stationary; the degree indicated by it must then be noted, when, by reference to the tables, the elevation of the spot where the experiment has been performed may be obtained. The temperature of the air should be observed by a common thermometer at the same time.



Professor Robison states that fluids boil in vacuo at 140° lower than under atmospheric pressure; consequently, water so circumstanced will boil at 72°. Dr. Thomson informs us that he has seen water boiling briskly at 98° in Mr. Barry's apparatus for distilling oils in vacuo.

We have now described the circumstances under which the boiling point of water is lowered by diminishing the pressure; and we shall proceed to show how, by increasing the pressure, the boiling point is raised.

When water is heated in vessels from which the vapour cannot escape except by overcoming pressure, its boiling point becomes very much raised. This experiment may be made in *Papin's digester*, which is a strong iron or copper vessel, with a tight-fitting lid screwed down, and provided with a safety-valve, loaded with any proper quantity of weights. In this way water may be heated to upwards of 400°; indeed, according to Muschenbroek, the temperature of water can be raised so as to melt tin, which fuses at 442°. A more convenient apparatus for this purpose was invented by the late Dr. Marcet. In this, the pressure is indicated by the height to which the steam raises a column of mercury, and the temperature is shown by a thermometer. It is represented in most treatises on Heat, but we may refer to Professor Miller's 'Chemistry,' vol. i. p. 227.

It should be observed that the temperature of the steam is always equal to that of the water from which it is generated. When however what is termed *high-pressure* steam is suffered to escape into the atmosphere, its temperature is greatly reduced, not merely on account of the cold air with which it comes into contact, but from the great expansion which it undergoes, and the consequent conversion of sensible into latent heat. In this case, it is so far from scalding like atmospheric steam, that it may be received upon the hand without feeling unpleasantly hot. When water is boiled in vessels which are not furnished with safety valves, or when from any accident they do not act or are overloaded, the strongest boilers burst with a tremendous explosion.

There are several circumstances which influence the boiling point of water besides those already noticed, though not to so great a degree. M. Gay Lussac found that water boiled exactly at 212° in a vessel made of tin plate, while in a glass one it acquired 214°; and he concluded that the boiling point varies according to the nature of the different vessels, and the state of their surfaces, in which the ebullition takes place, and consequently depends on their conducting power and the polish. It has been since ascertained that adhesion of the fluid to the surface of the vessel is the chief circumstance concerned in raising the boiling point. Thus, water may boil at 214° in a glass vessel, but if a pinch of iron filings be allowed to fall in, the adhesion will be diminished, and the temperature will sink to 212°. If the inner surface of the vessel be varnished with shell-lac, the temperature of 221° may be attained before the water boils; but the temperature of each gush of vapour is not more than 212°. The presence of a small quantity of oil in water has the effect of raising its boiling point 3° or 4°. The presence of air in liquids diminishes the adhesion, and greatly assists the evolution of vapour. By long boiling, so as to get rid of the whole of the air, Donny was able to raise its temperature in an open glass vessel as high as 360° Fahr., when it suddenly exploded into vapour with a loud report.

Dr. Bostock also found ('Annals of Philosophy,' vol. xxv. p. 196) that the boiling point of water is materially influenced by the presence of extraneous bodies. A saturated solution of common salt was placed over a lamp, and gradually heated up to 222°, when it boiled strongly; a test tube, containing water deprived of air by boiling, was plunged into the heated brine, and in a second or two it began to boil; the lamp was then withdrawn, and the brine soon ceased to boil, but the ebullition continued in the water for some time longer; it subsided at about 218° or 217°, but was constantly renewed by dropping in pieces of cedar wood. The brine was again placed over the lamp, and a test tube was plunged into it, containing a portion of water, together with a thermometer. The water in the tube did not begin to boil until the thermometer had risen to between 216° and 217°, when ebullition first commenced; the fragments of wood were then dropped in, and as usual very much increased the ebullition; and it was found that the water, kept at this temperature, had its ebullition promoted or suspended, according to the presence or absence of the extraneous bodies. Dr. Bostock concludes that in water the difference of boiling point occasioned by the circumstances described amounts to 4° or 5°, but in ether occasionally to 50° or more.

BOLE, ARMENIAN. [Bole, in Nat. Hist. Div.]

BOLETIC ACID. [Fumaric Acid.]

BOLE'TUS, MEDICAL USES OF. Several different species, all confounded under the name *B. igniarius*, furnished the means of stanching the flow of blood from wounds. They were supposed to do this by an astringent property; and, being erroneously referred to the genus Agaricus, were termed *agaric*, which word is often used as synonymous with *styptic*. Boletus possesses, however, no peculiar power of arresting the flow of blood, but acts mechanically like a sponge, and favours the formation of a clot. It is now almost entirely disused by British surgeons, but in some cases it merits a preference over other means of closing a bleeding vessel. When it is to be used, it must be rubbed firmly between the hands, doubled, and applied over the orifice whence the blood proceeds, and bound down by a compress. It should not be removed till after twenty-four hours, and the clot should be softened with *cold*, not warm water. Though the German tinder seems to offer a convenient substitute for the prepared agaric in case of an emergency, it would be very improper to employ it, as the nitrate of potass or saltpetre in which it is steeped would irritate and inflame the edges of the wound. [Amadou, in Nat. Hist. Div.] The German tinder, however, forms a very excellent moxa. The different kinds of Boleti used as styptics were formerly designated *Agaricus chirurgorum*.

It is less on account of their uses than of their peculiar habitudes, that the Boleti merit our notice. In chemical composition, odour, and habitudes, they resemble animals more than vegetables. When cut into, some of them exhibit almost a muscular structure (*B. hepaticus*, or *Fistulina hepatica*), hence called by the French *langue de bœuf*. The

Boletus igniarius, when divided, has been stated by Professor Eaton to heal like a flesh-wound by the *first intention*, or complete reunion of its divided edges, scarcely exhibiting a cicatrix or trace of the injury. (Silliman's 'Journal,' vol. vi.) Nitrogen enters into their composition; and in regard to their relations with the atmosphere, they inhale oxygen, and exhale carbonic acid gas. The *Boletus luridus* has been ascertained to abstract twelve per cent. of oxygen from the atmosphere in twelve hours. ('Inquiry into the Changes which the Atmosphere undergoes when in Contact with certain Vegetables which are destitute of Green Leaves,' by M. F. Marcet; Jameson's 'Edin. New. Phil. Journal,' October, 1835.)

Boleti consist largely of *fungin*, with some boletic acid. Unlike most fungi, which grow rapidly and perish quickly, most of the Boleti grow very slowly, acquire a firm texture, and last perhaps 100 years if not exposed to much moisture. According to Sir William Jones, the *B. igniarius* is found in India, and used in nearly the same manner as in Europe. (Ainslie's 'Materia Medica Indica,' vol. i. p. 6.)

Boletus edulis (esculent Boletus, called in France Ceps) is not only extremely nutritious, but esteemed by the French an exquisite luxury. It is as susceptible of cultivation as the common mushroom. (See Dr. Badham, 'On the Esculent Mushrooms of England;' and Mrs. Hussey's 'British Mycology.')

BOLOGNESE SCHOOL OF PAINTING. The historians of the fine arts employ the word school, as it is often used in reference to other pursuits, only to denote a similarity of opinion, aim, or practice among many individuals; but the term is so far true to its literal import, that the similarity of taste alluded to does not so much arise from the accidental coincidence of independent modes of thinking, as from some common influence, and generally from the example of one powerful mind. Nor does this always involve a defect of originality: in the complicated art of painting the advances to perfection were of necessity very gradual; the greatest masters were largely indebted to the labours of their predecessors, and each of them may thus be said to have sprung from a school as certainly as that he founded one. But when excellence was once approximated, originality seemed only compatible with a difference in the mode, since a difference of degree appeared to be no longer possible; and while the desire of novelty sometimes degenerated to caprice, and imitation ended in insipidity, the most plausible ambition seemed to be that which aimed at combining excellences not hitherto united in any one school. This was at least the professed object of the Caracci, the most celebrated among the Bolognese masters. It happens that this new effort took place in a school which had not before distinguished itself so greatly as the rest. The most brilliant epochs of art, south of the Alps, concur; the greatest masters having been contemporary with each other in the beginning of the 16th century. To this rule, which applies to Venice, Parma, Florence, and Rome, the Bolognese school is an exception, since it attained its comparative perfection nearly a century after the production of the finest works of Italian art.

The merits of the most distinguished later masters of the Bolognese school have been done ample justice to by many historians and biographers, but it must be confessed that the Florentine Vasari, who was naturally anxious to extol the genius of the Tuscan artists, sometimes betrays a disposition to undervalue or to vilify the earlier Bolognese painters whom he notices in his work, and he did not live to see the revolution which the Caracci produced. The chief historian of the Bolognese school, Malvasia (Felsina Pittrice), on the other hand, in his eagerness to defend his countrymen, has not unfrequently exaggerated their merits, and the two should be compared with the more impartial opinions of recent writers, among whom Lanzi, though again perhaps disposed to exalt his own Florence, will be found the most rational.

The arts of design were kept alive during the middle ages by mosaics and by illuminated manuscripts; the former were commoner at Rome and Ravenna than in the other Italian cities, but the art of missal-painting, which was practised wherever there was a monastery, seems to have attained some perfection at Bologna at an early period. The Franco Bolognese mentioned by Dante ('Purgatorio,' canto 11) as superior in this art to his master, Oderigi di Agubbio, it appears sometimes painted in larger dimensions, and the recorded dates of still earlier painters might enable Bologna to contend for the palm of antiquity not only with Florence but with Siena and Pisa. Franco, who has been called the Giotto of his school, is the supposed founder of the style of the Bolognese painters of the 14th century. Many of their now fading works exist in the church di Mezzaratta, a gallery, as it were, of ancient specimens which, as Lanzi remarks, is to this æra of the Bolognese school what the Campo Santo at Pisa is to that of the early Florentines. In order, however, that this comparison should be just, it would be necessary to select corresponding dates; some of the works in the Campo Santo, as for instance those of Benozzo, were executed after the middle of the 15th century.

About 1400 the most prominent name is Lippo Dalmasio, called, from the subjects to which he almost confined himself, Lippo delle Madonne; some of his works remain, and Malvasia relates, with reference to one in the church of S. Procolo, that he heard Guido extol its purity and grandeur of expression, and assert that, notwithstanding the subsequent advancement of the art, no modern painter could infuse so holy a feeling into similar subjects. In this early epoch of

the school the predilection for the style of the Greek paintings, the common prototypes of Italian art, seems to have been more decided, and to have lasted longer than any other. It may be here observed that the modes of representation to which the Byzantine painters and their Italian followers adhered were in many cases consecrated by tradition, but independently of this the works themselves, rude as they were, often exhibited a solemnity of treatment which may in some degree account for the veneration in which they were held. The Florentines who visited Bologna and painted there left no permanent impression; a native artist, Marco Zoppo, who studied at Padua (where he was the rival of Mantegna) and afterwards at Venice, introduced the arrangement of the Venetian altar-pieces in some works subsequently done by him in Bologna; but the early simplicity or severity was preferred perhaps as fitter for religious subjects, and was rather confirmed than discarded by the greatest painter of the first epoch, Francesco Francia. This artist, who was contemporary with Raffaelle, and survived him some years, according to Malvasia, was celebrated as a goldsmith and engraver of medals before he betook himself to the pencil at a comparatively advanced age. Vasari says that he was born in 1450, and that his first picture was dated 1490; but he had probably attained some celebrity before then, as in that year he was employed to paint the altar-piece of the Bentivogli chapel, and on other works of importance—though on the altar-piece just mentioned he is said by Lanzi to have signed Franciscus Franci, Aurifex, thus implying that he still regarded himself as much a goldsmith as a painter. Francia is celebrated as a painter who succeeded beyond most others in giving an expression of sanctity and purity to his Madonnas, and a letter of Raffaelle's is extant in which this merit is particularly alluded to. Francia, who, in that middle style which the Italians have called *antico-moderno*, ranks with Perugino and Bellini, should, like them, have preceded the highest development of the art in a Raffaelle or a Titian; but it is precisely in this highest corresponding point that the Bolognese school is wanting, and the eulogists of Francia have in vain endeavoured to exalt him to a level with the painters of the first rank with whom he happens nearly to coincide in date. Vasari relates that when the St. Cecilia of Raffaelle made its appearance in Bologna, according to him in 1518, Francia, to whose care it had been consigned by the great painter himself, was so amazed at its vast superiority to his own efforts that he soon after died of mortification. Francia, it has recently been proved (Calvi, 'Memorie della Vita e delle Opere di Francisco Raibolini, detto il Francia') did in fact die in the beginning of that year, but Vasari's story has received no other confirmation, and its accuracy may well be doubted: he was in his 68th year at the time of his death. The school of Francia presents no distinguished names. The summit of the art had been already reached elsewhere, and his followers, who were inferior to him, were eclipsed by the disciples of Raffaelle.

These introduced a more or less servile imitation of the style of their great model into Bologna; the best were Ramenghi called Bagnacavallo, and Innocenza da Imola. It is in the account of Bagnacavallo (which includes a notice of Innocenza, Aspertini, and Girolamo da Cotignola) that Vasari speaks so contemptuously of the Bolognese school. Bagnacavallo was however occasionally original, and some of his productions were considered worthy of the particular attention and study of succeeding masters. Three distinguished names precede the epoch of the Caracci: Primaticcio, Niccolò dell' Abate, and Pellegrino Tibaldi. Niccolò dell' Abate belongs strictly to the school of Modena, but he is associated with the Bolognese painters by some works at Bologna, by his joint labours with Primaticcio at Fontainebleau, and by the extravagant compliment paid to him in a sonnet by Agostino Caracci, in which he is said to unite all the excellences of all the great masters. Primaticcio and Tibaldi began their studies, though at very different times, under Bagnacavallo; the first, who was the elder by many years, assisted Giulio Romano at Mantua, and under his direction acquired a facility and a classic taste which he afterwards displayed in a series of designs for the ceilings of Fontainebleau, where he was employed by Francis I. and his successors. The frescoes painted from these designs, and which are now no longer in existence, were chiefly executed by Niccolò dell' Abate. Pellegrino Tibaldi soon left Ramenghi for Rome and Michael Angelo, to whose style he devoted himself; his successful imitation of the great Florentine master, whose powerful design he sometimes blended with the excellences of other schools, places him in a relation to his prototype similar to that which Bagnacavallo holds to Raffaelle, and the Caracci honoured him with the appellation of "the Reformed Michael Angelo." Tibaldi was employed in Milan, and afterwards in Spain, and thus the three greatest masters of this intermediate period were absent from Bologna a great part of their lives.

The name of Prospero Fontana stands at the head of those who, living from the earlier to the latter part of the 16th century, and inheriting but little of the genius of the great masters, survived their own slender reputation to witness the rising fame of the Caracci. In the same class may be mentioned Passerotti, as the latest Bolognese painter alluded to by Vasari. The others may be passed over, with the exception of Denis Calvart, a native of Antwerp, who, after settling in Bologna, where he opened a school, not only had the honour of partly instructing Guido, Domenichino, and other celebrated Bolognese painters, but also of introducing that elevated style of landscape-

painting which afterwards added a new lustre to the school in the hands of the Caracci, Domenichino, Grimaldi, and others.

Thus the imitation of the two great Florentine and Roman masters lasted with no other change than that of increasing mannerism or insipidity, till beyond the middle of the 16th century, about which time the followers of the elder Zuccaro in Rome and those of Bronzino in Florence may be ranked with the Fontanas and the Passerottis of Bologna. The characteristic excellence of the Venetian school had been occasionally blended with the other styles, but in general the influence of each was separate and exclusive: meanwhile, owing to the ascendancy of the two first, the imitation of Correggio can hardly be said to have extended uninterruptedly beyond his own date, since Parmigiano, who indeed rather holds the rank of an original master, survived him but a very few years. Baroccio may therefore be considered to have led the way, about 1565, not only in including Correggio among the great models proposed for imitation, but even in preferring him to the rest. The example thus set to the Roman school was followed soon after by Cigoli in Florence, namely about 1580, a period which immediately precedes the dawning influence and fame of the Caracci. They too, from whatever cause, partook of the new admiration, and in their attempt to unite the excellences of the different schools, it was natural that a style, which had been hitherto in a great measure overlooked, should form a chief element of that eclectic perfection which was proposed as the object of attainment. Accordingly, the imitation of Correggio preponderates in the first works of these masters; and Annibale Caracci's letters from Parma prove that, like many other painters of the day, he considered the excellence of Correggio as a new discovery.

Lodovico Caracci, who had studied in Venice, Florence, and Parma, conceived the plan of introducing a new style, according to his biographers, when alone and unassisted, and it is said that he persuaded his younger cousins Agostino and Annibale to devote themselves to painting in order to aid him in effecting his purpose. He sent them, after well-grounded elementary studies, to Parma and Venice, from the latter of which schools it may be observed the Bolognese painters seem to have borrowed least. The first work of importance done after their return to Bologna was a series of compositions, representing the story of Jason, in an apartment of the Palazzo Fava: Lodovico himself assisted, but the greater part was the work of Annibale. The severe criticisms and opposition which this performance excited induced the Caracci to strengthen their party, and the famous school was opened which shortly attracted most of the rising painters who were studying with Denis Calvart, Cesi, and Fontana:—ample details as to the mode of study in the school of the Caracci may be found in Malvasia. The fame of these masters was soon after firmly established by their works; and Agostino, as an engraver as well as a painter, contributed to spread and sustain their name: but the enmity of the abettors of the old style was not completely silenced till the frescoes in the Palazzo Magnani were executed. Denis Calvart was the last to fall in with the general approbation; and it appears from Malvasia that his chief objection to the new mode of study was the constant reference to nature which was now deemed indispensable: from this objection the previous state of the schools and the manner of the painters of Bologna may be inferred.

Annibale Caracci repaired to Rome about or shortly before 1600, and painted in various churches; but his great work, the monument of his powers, and the specimen of the school most frequently quoted, although not perhaps the most characteristic, is the series of frescoes in the Farnese palace. In this work Agostino among others assisted: the Cephalus and the Galatea, according to Bellori, were painted entirely by him. The admirers of the antique and of the Roman school prefer this work even to Lodovico's performances in Bologna: Poussin and other painters, who visited Rome early in the 17th century, gave it the highest praise.

The followers of Lodovico at Bologna were, however, true to the founder of the school: posterity seems to have confirmed the opinion, and to have decided that this great painter, with less academic power than Annibale, is more original in style. Sir Joshua Reynolds thus speaks of Lodovico Caracci: "His unaffected breadth of light and shadow, the simplicity of his colouring, which, holding its proper rank, does not draw aside the least part of the attention from the subject, and the solemn effect of that twilight which seems diffused over his pictures, appear to me to correspond with grave and dignified subjects better than the more artificial brilliancy of sunshine which enlightens the pictures of Titian." (Discourse II.)

The principles and practice of the Caracci and their scholars superseded for a time every other style in Italy; yet it may be remarked that the efforts of Lodovico can hardly be considered so spontaneous and independent as the historians of art have commonly asserted. It has been already shown that a new impulse had manifested itself in the Roman and Florentine schools, even previously to the revolution which the Caracci effected; and whatever may have been the origin of that impulse, the sudden rise of various and powerful talents in Bologna may be considered a symptom rather than the cause of general improvement.

Among the numerous scholars of the Caracci, Domenichino holds the first rank; but the merit of this painter was long unnoticed in Rome, where he resided some time, owing in some degree to the intrigues of his rivals. Poussin had the honour of bringing some of his best works into notice, and declared him to be, in his opinion, the greatest painter after Raffaelle. By some modern critics, too, he has been preferred to the Caracci themselves: his chief excellence, and that in which he approaches Raffaelle, is his expression. The graceful Albani, who left the school of Calvart for that of the Caracci, perhaps like Domenichino imbibed his taste in landscape from the Fleming: he communicated it to Francesco and Giovanni Battista Mola, who often suffered it to predominate in their own historical works, and who occasionally painted the landscape backgrounds to the figures of Albani: these consisted frequently of females and children in subjects connected with poetry or allegory, and he excelled in them perhaps more than in sacred subjects. The more brilliant talents of Guido excited the jealousy of the Caracci from the beginning. Lodovico encouraged Guercino as a rival to him, and Domenichino was put forward, it is said, for no other reason, by Annibale in Rome. The light and silvery tone which is observable in some of Guido's best works is said to have been owing to an accidental expression of Annibale Caracci, who at a time when the dark style of Caravaggio excited general attention, and was imitated among others by Guido himself, remarked that the opposite treatment, with appropriate subjects, would perhaps be still more attractive. Caravaggio, who was born in the Milanese, and painted in Rome, Naples, and elsewhere, cannot be placed in the Bolognese school, which however he greatly influenced: he belongs to the successful innovators who, at the close of the 16th century, sought to oppose literal and unselected nature to the insipid imitation of the purer styles, and may be considered the chief representative of a class of painters called by the Italians the *Naturalisti* and the *Tenebrosi*. Among the painters of the Bolognese school, Guercino, born at Cento, seems to have been most smitten with the vigorous effects of Caravaggio, although in his latest practice he acknowledged the charms of Guido's style, by attempting to unite it, perhaps with little success, to his own. His dark pictures are generally his best, and he sometimes united the higher qualities of expression and of form with the magic of his relief. Both Caravaggio and Guercino studied in Venice, and the former particularly aimed at the style of Giorgione; yet their works, however admirable, present but few traces of Venetian principles, and this is to be accounted for by the spirit of innovation which manifested itself in every branch of the art, and which took the opposite of the vices of the day. The negative and somewhat heavy colour of the two masters alluded to was opposed to a florid and weak imitation of the colourists, the excesses of which are ridiculed by Boschini in his 'Carta del Navegar Pittoresco.'

Lanfranco, born at Parma, was another distinguished scholar of the Caracci, and assisted Annibale in the Farnese palace in Rome: his own great work, the cupola of St. Andrea della Valle in the same city, is the best specimen of his powers, and it is here that as a machinist (the term applied by the Italians to painters of large compositions on ceilings and in galleries) he aimed at the grandeur of manner and boldness of foreshortening which he had long studied in the works of Correggio at Parma.

Of the remaining disciples of the Caracci it may be sufficient to mention the names of Tiarini, Lionello Spada, and Cavedone. All the more noted scholars before mentioned had numerous followers, and perhaps none more than Guido. In these the manner of the respective masters naturally degenerated, and no new talent arose. The taste in landscape which the Caracci introduced or improved was inherited and almost exclusively practised by Giovanni Battista Viola, the Grimaldi, and others: the most perfect specimens of this branch of art, as practised in the school, are however to be sought in the works of Domenichino and Annibale Caracci.

About the year 1700 the greatest name was Carlo Cignani, a painter of considerable repute in his day, and who so far revived the principles of the school that he professed to unite the anatomical science of Annibale Caracci with the more attractive qualities of Correggio. Under his auspices the Clementine Academy of Bologna was instituted, to preserve as much as possible the acknowledged principles of the art, and to point out the best models for imitation. But while the impulse which the Caracci and their scholars had communicated to the school was gradually exhausting itself, a pernicious and in many respects opposite tendency had been gaining ground. The specious facility and consequent popularity of the machinists, who imitated Vasari in Florence and the Zuccari and Arpino in Rome, had been with difficulty opposed by the united efforts of the Caracci, and appear to have been the chief causes of the neglect of Domenichino. This empty facility, no longer contrasted with such distinguished talents, was naturally considered the highest proof of ability, and by degrees almost extinguished the taste for well-studied imitation. A Bolognese writer and painter, Zanotti, who was long professor of the Clementine Academy, was one of the first to raise his voice against this destructive mannerism, and to recommend a more frequent reference to nature. He has been considered to have led the way to opinions far more decided than his own as to the necessity of returning to the first principles of imitation, and indeed to the methods of the earliest masters. These notions have been openly expressed in Germany, where the writers on art, allowing for some exaggeration in their views, have had the merit of directing the attention of the world of taste to the simple but impressive productions of the older Italian painters,

from whom Raffaelle caught the feeling which aided him in his study of nature; and they have been, to a certain extent, adopted by the band of young painters in this country who assumed the designation of Pre-Raphelite Brethren.

To recapitulate, the school of the Caracci has been often described as merely imitative, but perhaps this has arisen rather from the well-known and professed object of its institutors and followers than from a particular evidence of that object in their productions. If a certain resemblance of manner, whatever it be derived from, characterise the masters, it may be admitted that no school presents so much variety as is to be met with in the works of their disciples. This, it must be confessed, cannot be said of the followers of Michael Angelo and Raffaelle. The example of an eclectic style may thus lead to a more original style, whereas the example of an original style, if it cannot be surpassed, can only end in a weaker copy. Yet assuming that the Caracci were as independent of the spirit of their age and as free to choose their path as their biographers would lead us to suppose, had they endeavoured to follow up the feeling of Francia (not to return to Lippo Dalmasio or to Giotto), they might have succeeded in connecting the highest effort of the school with that earlier, national, or local style, which, as we have seen, was nipped in its growth before it was fully developed, partly perhaps because Francia devoted himself so late in life to the art, and thus still adhered to the incomplete and, as it were, preparatory mode of imitation when the perfect one had already been introduced. The merit of this painter, as one of the characteristic Italian masters, should not however be forgotten, and his style is not the less interesting from being connected with that original school of Umbria, distinct from the Florentine, which was remarkable for purity of expression, and which had so much influence on the education and genius of Raffaelle.

We will only add that our National Gallery contains the following works of painters of the Bolognese school, taken in their chronological order:—Of the 15th century, there are by Marco Zoppo (who painted from 1471 to 1498) 'St. Dominic as the Institutor of the Rosary' (a good example of the mystical tendency which Rio terms the distinctive feature of the early school of Bologna); and by Francia (1450-1518), 'The Virgin with the Infant Christ and St. Anne enthroned, surrounded by Saints,' and a 'Pietà' (or 'Virgin and two Angels weeping over the dead body of Christ'), which served as the lunette to the former, the two pictures together forming the altar-piece of the Buonvisi chapel in the church of San Fridiano at Lucca. Of the 16th century, there are by Lodovico Caracci (1555-1619) an 'Entombment of Christ,' and 'Susannah and the Two Elders;' by Agostino Caracci (1559-1602) two cartoons, 'Cephalus and Aurora,' and 'Galatea;' and by Annibale Caracci, no fewer than eight paintings, 'Christ appearing to Peter after his Resurrection,' 'St. John in the Wilderness,' 'The Temptation of St. Anthony in the Desert,' 'Silenus gathering Grapes,' 'Pan teaching Apollo to play on the Pipes,' 'Erminia takes refuge with the Shepherds,' and two landscapes. Of the 17th century, by Domenichino (1581-1641), 'The Stoning of St. Stephen,' 'St. Jerome and the Angel,' and two landscapes; by Guido (1575-1642), 'Lot and his Daughters leaving Sodom,' 'The youthful Christ embracing St. Peter,' 'Ecce Homo,' 'The Magdalen,' 'The Coronation of the Virgin,' 'Susannah and the Elders,' 'St. Jerome,' 'Perseus and Andromeda,' 'Venus attired by the Hours;' by Guercino (1592-1666), 'Angels weeping over the Dead Body of Christ;' and by Pietro Francesco Mola (1612-1668), 'St. John Preaching in the Wilderness,' and 'The Repose of the Holy Family.' (Ample descriptions of these pictures will be found in the excellent 'Catalogue of the National Gallery,' by R. N. Wornum.)

BOLOGNIAN PHOSPHORUS. [Barium; *Baryta, Sulphate of.*]

BOLORETINE ($C_{40}H_{32}O_6$?) is the name of one of four resinous compounds found in the peat of Denmark, on the remains of pine trees. It is a fusible compound, but not crystalline.

BOLSOVER STONE. The yellow limestone of Bolsover in Derbyshire has been used in the construction of the new Houses of Parliament. It was selected for its durability, strength, fitness for ornamental work, and colour. It is a combination of carbonate of magnesia with carbonate of lime, in small granular crystals, without the slightest trace of organisation, flinty nodules, or other blemishes. It was subjected to various and severe mechanical pressures, chemical reagents, &c., and sustained them with credit; but experience has shown that it cannot withstand the atmosphere of London any more than the Bath and Portland oolites.

BOLTHEAD, a chemical vessel, usually of green glass, and of a globular form, with a narrow neck. It is chiefly employed in the processes of ebullition and sublimation.

BOMB, the original name of what is now called a shell, is a hollow globe of iron, which, when charged with a certain quantity of gunpowder, is projected from a mortar or howitzer, generally at a considerable angle with the horizon; in order that, by the momentum acquired in its descent, it may crush through the roof, and, by exploding, destroy any building on which it may fall. The name is thought to have been given as an expression of the sound produced either in the explosion, or at its discharge from the piece of artillery employed to project it.

It is said by Strada, in his account of the wars in the Low Countries, that bombs were employed for the first time in 1588 by Ernest, the father of Charles, Count of Mansfeldt, at the siege of Wachtendonk, a town near Gelders. He adds that they were invented, a few days before that siege commenced, by an inhabitant of Venlo; and it is stated that the people of this city, wishing to exhibit the invention in presence of the Duke of Cleves, discharged a bomb, which falling on one of the houses set fire to it, and, the flames spreading, three-fourths of the town were destroyed before they could be extinguished. (Père Daniel, 'Histoire de la Milice Française,' liv. vii. chap. 6.) But Grose relates that a French translation, made in 1555, of a work by Valturinus, was accompanied by a print representing a cannon just fired, with a ball in the air and another on the ground, both of which were burning at the vent. A title to the print denoted that this was a contrivance for firing a ball filled with powder; and as the first edition of Valturinus is dated 1472, it appears from thence that bombs must have been invented about the middle of the 15th century. Blondel, however, in his treatise entitled 'L'Art de Jetter les Bombes,' remarks that bombs were used by the French for the first time in 1634, at the siege of La Mothe, under the direction of one Malthus, an English engineer, who was invited from Holland by Louis XIII., and was afterwards killed at the siege of Gravelines.

In 1688, there was cast in France an enormous bomb, which is said to have been in the form of an egg, and to have been capable of containing 7000 or 8000 pounds of powder; it was nine feet long and five feet in diameter, and the iron was six inches thick. The bomb was to have been discharged against the Algerines, and the ship in which it was embarked was to have been blown up with it. It was not however employed, probably in consequence of an opinion that it would not have had the intended effect, and no attempt has since been made to project such an immense mass of metal. While the Citadel of Antwerp was besieged by the French army in 1832, shells twenty-four inches in diameter were thrown from the largest mortar which has been employed in modern warfare; the shell or bomb was capable of containing ninety-nine pounds of powder, and when charged weighed 1015 pounds.

The word bomb being now nearly superseded, except as a component in those which express the subjects of the three following articles, and in the term bombardier, which is applied to the soldier whose duty it is to serve the ordnance from which shells are projected, the description of this missile will with most propriety be introduced under the words which denote the different species at present in use: as Carcass, Case-Shot, Grenade, and Shell.

BOMB-PROOF. This name is given to a military magazine, or other building, when its roof has sufficient thickness to resist the shock of shells from mortars falling on it. Under the word Blindage is given the construction of such buildings of timber as are intended to secure troops or artillery from the effects of what is called vertical fire; and under the word Casemate is shown that of the vaults which are formed in the masses of ramparts to serve for the like purposes. A bomb-proof however is generally understood to signify an isolated building, rectangular on the plan, formed of brick or stone, and covered with a vaulted roof of the same material. The intrados, or interior line, in a vertical and transverse section of the vault, is sometimes a semicircle, but now more generally a parabola; and the exterior surface of the roof is formed by two inclined planes meeting in a ridge which is parallel to the sides of the building and over the middle of its breadth. By this construction, the greatest thickness is given to the crown, or centre part, where a falling shot or shell would be most injurious to the stability of the arch of the vault. It is intended to serve as a powder- or store-magazine, an hospital, or to cover a battery of guns or mortars; and when constructed in a fortress for the first of these purposes, it should not only be isolated, but should also be situated in some spot at a distance from the fronts likely to be attacked, and secured as much as possible against accidents.

As the details of the construction and uses of such buildings are given under Magazine, it is only necessary to observe here, that the span, or interior width of a bomb-proof vault, is usually about eighteen feet, and the thickness of the arch three feet at the hances or sides. But the extrados, or exterior of the vault, should be covered with a bed of earth about five feet deep, to deaden the concussion produced by the shells which may strike it; this earth should be renewed as fast as it is blown away by the explosions, to prevent the shell from falling on the naked vault; for, as each shell would tear off the masonry to the depth of two or three inches, it is evident that the building would be totally destroyed after a few successive shocks.

BOMB-VESSEL. What was, till recently, called a "bomb-vessel," was a ship of about 350 tons burthen, intended to co-operate with a fleet or squadron, in throwing shells from mortars of large dimensions, such shells being 13-inch or 10-inch: they were in addition armed with light carronades. A greater *beam* or breadth was generally given to these vessels, and their heavy mortars worked on traversing platforms so as to command a wide horizontal range. Great changes, however, are taking place in this class of vessel, and in this arm of naval service—mainly due to the invention of Sir William Armstrong. These will be described under the word Mortar-boat.

BOMBARDIER, a non-commissioned officer of the royal regiment of artillery, whose duty it used to be to load shells, grenades, &c.; to make and fix the fuses, and who was particularly appointed to the service of mortars and howitzers. At present the term is merely applied to the non-commissioned officer who holds the same rank as a

lance corporal in the line. There are a certain number of bombardiers to each company of artillery.

BOMBARDMENT. This is the action of throwing shells, carcasses, and shot into an enemy's town in order to destroy the buildings, and chiefly the military magazines; for which purpose mortar, howitzer, and gun-batteries are constructed in convenient situations, generally opposite to the most densely inhabited quarters. If the town is a seaport, bomb-vessels also are moored along the shore, and the firing is kept up simultaneously on the land and sea-sides of the place.

When an army invests a fortress, whether it proceed against it by the operations of a regular siege, or simply keep it in a state of blockade, a bombardment is one of the means resorted to in order to accelerate the surrender, by rendering its occupation dangerous to the citizens, and ruining the buildings in which the ammunition is secured, or in which the garrison while not on duty find repose.

Among civilised nations it has become a principle to spare as much as possible the lives and property of individuals who are not actually engaged in the military service of the state against which an army is employed; since, besides the cruelty of acting otherwise, the object in view, which is the final termination of hostilities, is not in the smallest degree advanced. The practice of besieging fortresses is now so far reduced to a regular process that the time of their surrender may be confidently anticipated by so employing the artillery that, while it effectually dismounts that of the enemy, and lays the rampart in ruins in the ditch, it scarcely produces the smallest injury to any but the defenders of the works: hence the simple bombardment of towns occurs so much less frequently now than in former times, and no circumstance is considered as a justification of the measure except the absolute inability to reduce a place by other means.

When a town is, from the fate of war, about to become subject to a bombardment, the garrison should endeavour to retard the calamity by the erection of advanced works about the place, or by keeping troops in the suburbs and neighbouring villages as long as possible. By this measure provisions, materials, and even workmen will be obtained in abundance for the service of the defenders; the inhabitants of the fortress also, finding that the garrison is not shut up within the walls, will be inspired with confidence in its protecting power, and thus induced to suffer less unwillingly the privations and dangers to which they must inevitably become exposed. The enemy moreover will be compelled either to abstain from constructing a line of *countervallation*, as it is called, to prevent the sorties of the garrison; or, if such is attempted, the line must be so extensive as to require a long time for its formation, and the works constituting it must be so far asunder as to render it impossible to watch the avenues of the place with sufficient care to prevent all communication between the town and country. The power of acting offensively may thus be not wholly taken away from the garrison, and the enemy may be kept at such a distance as to lessen materially the effect of the bombardment. What has been said must not be understood to imply that any village, suburb, or building, which by falling into the power of the enemy might facilitate his operations, is not to be destroyed before he can get possession of it; but it is evident that the object in view, which is the preservation of the place, and of its docks and arsenals, if it be a naval station, will be most effectually obtained by keeping the enemy as long as possible at a distance from them beyond the range of his artillery.

The garrison must of course employ a fire of the heaviest artillery to destroy the enemy's batteries as soon as they are formed. The casemates and blindages in the town should be repaired and multiplied; and the ammunition should be kept in small quantities in each, in order to avoid the loss and damage which would be occasioned by the explosion of a large, and full magazine; for which reason also, it should be disposed in the quarters least subject to the fire of the enemy. Wells and cisterns should be protected by shell-proof blindages, the fire-engines carefully secured, and companies of men formed whose duty should be to proceed immediately with the engines to any spot where a fire may have broken out. The utmost intrepidity is required in men employed on this service, which is rendered particularly dangerous, because the enemy always continues to direct his fire towards any spot at which flames are seen to rise, in order to prevent if possible the defenders from extinguishing them. When red-hot shot are thrown into a town, men should always be appointed to seek them and, by pincers or otherwise, remove them to places where they can do no harm.

A strict police is to be maintained, and every precaution used to prevent conspiracies among the citizens for delivering up the place. For now, since the loss of a town does not, as in ancient warfare, entail upon the inhabitants the loss of life or liberty, it is easy to conceive that their interest in their property must unavoidably lead them to desire the cessation of the bombardment, though at the price of the transfer of the town to the enemies of their country; and it must be expected that they will use every means in their power, whether of persuasion or force, to compel the commander to surrender.

The most celebrated bombardments mentioned in history are those of Gibraltar, Copenhagen, Algiers, and Sebastopol. The first of these places was invested on the land-side by a Spanish army, which was afterwards united to that of France, and on the sea-side by the combined fleets of the two nations. The investment took place in 1779, but no remarkable actions occurred till 1782. The town was twice distressed for want of provisions; the highest works of the fortress, though 1340 feet above the level of the enemy's batteries, were destroyed by shells from the latter several times; attempts were also made by the besiegers both to fire the ships in the harbour and to annoy the British army by gun-boats.

On the other hand, the garrison was employed in strengthening the old fortifications and adding new batteries, and in making occasional sorties against the Spanish lines. In the last-mentioned year, however, the besiegers converted some of their large ships into floating batteries, which, on September 13, commenced a tremendous fire on the town, while the land-batteries cannonaded the works in flank and rear; the garrison, in return, paying little attention to these, poured on the ships a fire of carcases, shells, and red-hot balls. This work of destruction continued on both sides till about seven or eight P.M., when it nearly ceased. The utmost confusion and distress by this time prevailed in the fleet of the besiegers; several of their largest ships had caught fire, and two of them blew up with tremendous explosion. The general peace, which was made in the beginning of the next year, put an end to this memorable siege after it had been carried on nearly four years.

The bombardment of Copenhagen took place in 1807, and was effected by a British army under Lord Cathcart, which closely invested the city on the land side, while the fleet under Admiral Gambier blockaded the harbour. The fire from the land-batteries and bomb-vessels opened on the evening of September 2, and continued till the night of September 4, when a capitulation took place. In this bombardment the rockets invented by Sir William Congreve were used for the first time; and it is said that the cathedral, with above 300 houses, was destroyed by the shot and shells which were thrown into the town. Another action of this nature occurred in 1816, when the united fleets of England and Holland, consisting of fifteen ships of war, besides gun-boats, under the command of Lord Exmouth, bombarded Algiers. The firing continued during twelve hours, in which time all the enemy's ships in the harbour were destroyed and great part of the town.

The last bombardment was that of Sebastopol, which can perhaps hardly be strictly termed a bombardment, as though a good deal of the fire was directed on the town, the principal part was on the works. The following is a return of the shot and shell expended by the English alone in the six successive bombardments:—In the first bombardment, commencing October 17th, 1854, 72 siege guns were employed, and they fired 21,881 rounds. In the second, commencing April 9th, 123 guns fired 30,633 rounds. In the third, commencing June 6th, 155 guns fired 32,883 rounds. In the fourth, commencing June 17th, 166 guns fired 22,684 rounds. In the fifth, commencing August 17th, 196 guns fired 26,270 rounds. And in the sixth and final bombardment of the 8th of September, 207 guns and mortars fired 28,476 rounds. In addition to this, 88,640 rounds were fired at different times, between the regular bombardments, and 405 rounds of *carcases* and *light-balls*, giving a total of 251,872 rounds of shot and shell fired during the whole siege, or about 6000 rounds a week. The expenditure of ammunition by the fleet was also enormous, as the Agamemnon alone, in the attack of the 17th of August, in about four hours fired more than 3000 rounds.

BOMBAZINE (from the Greek *βόμβυξ*, which signifies both the silk-worm and the silk produced by it) is a woven fabric in which the warp is formed of silk, and the weft, or shoot, of worsted. The worsted is thrown on the right side, which has a twill upon it. The manufacture originated in Norwich, among the Dutch who were settled in that city, about 1575. Bombazines were formerly made of various colours, but owing to changes of fashion they are now manufactured almost entirely in black, and are now only used, and that to a limited extent, as mourning.

BOMBIC ACID. The silkworm, especially in the chrysalis state, contains an acid liquor, and hence the name of bombic acid. It was discovered from the circumstance of blue paper, which had been accidentally laid near these insects while changing to the state of chrysalis, being found covered with red spots, as if drops of acid had been spilled upon it.

When the insect is subjected to pressure it also yields a liquor from which alcohol precipitates mucilage, oil, and glutinous matter, and leaves bombic acid in solution; by evaporating this there is obtained an acid pungent fluid of an amber colour, which reddens vegetable blue colours, and forms salts with the alkalies, earths, and metallic oxides, which have been called *bombiates*.

This acid product has not been examined of late years, and is scarcely noticed by modern authors. Neither its nature nor that of its salts is accurately known; and it is not even certain that it is a peculiar acid. It is probable that a re-examination would show that it is similar to the formic acid, or acid of ants.

BONA FIDES and BONÂ FIDE is an expression often used in the conversation of common life. It is also often in the mouths of lawyers, and it occurs in acts of parliament, where (in some cases at least) it means that the act referred to must not be done to evade the law, or in fraud of the law, as we sometimes express it, following the Roman phraseology, in fraudem legis. It appears to be used pursuant to the meaning of the words, in the room of good faith, which implies the absence of all

fraud or deceit. Bona Fides is therefore opposed to fraud, and is a necessary ingredient in contracts, and in many acts which do not belong to contracts. How much fraud may be legally used, or what is the meaning of Bona Fides in any particular case, will depend on the facts. Many things are not legal frauds, and many things are legally done Bonâ Fide, which the common notions of fair dealing condemn.

The phrase Bona Fides originated with the Romans, and it is opposed to Mala Fides, or Dolus. The notion of equity (æquitas), equality, fair dealing, equal dealing, is another form of expressing Bona Fides. He who possessed the property of another *bonâ fide*, might, so far as the general rules of law permitted, acquire the ownership of such property by use (usucapio). In this case bona fides consisted in believing that his possession originated in a good title, or, as Gaius (ii. 43) expresses it, when the possessor believed that he who transferred the thing to him was the owner.

The Romans classed under the head of *bonæ fidei* obligations a great variety of contracts, and also of legal acts, as buying, selling, *mandatum*, guardianship, &c. Actions founded on these obligations were called *bonæ fidei actiones*, a name which arose from the formula "ex bonâ fide," inserted in the Intentio, or that part of the Prætor's formula which had reference to the plaintiff's claim, and empowered the judex to decide according to the equity of the case, *ex fide bonâ*. Thus actions founded on contract, or on acts which bore an analogy to contract, were distributed into *stricti juris actiones* and *bonæ fidei actiones*; or actions in which the inquiry was about the strict legal rights of the parties, and actions in which the general principles of fair dealing were to be taken into the account. The object which was attained by the latter bears an analogy to the relief which may be sometimes obtained in a court of equity in England, when there is none to be had in a court of law.

BONA NOTABILIA. [Executors.] The doctrine of *Bona Notabilia* has been abolished with the Courts whose jurisdiction depended on it, there being now but one Court of Probate for all England. [Probate.]

BOND. A bond or obligation in law, is a deed by which he who makes it, called the *obligor*, binds himself to another called the *obligee*, to pay a sum of money, or to do, or not to do, any other act. It is, in fact, a species of covenant. [Covenant.]

Bonds for the payment of money are the most common. They are employed instead of promises by word, or by unsealed writing, for the following reasons. First, a bond (like every covenant) to pay a sum of money may be enforced against the obligor, although no legal motive or *consideration* existed for making it (which is not the case with a verbal promise), for a deed cannot be set aside by the maker of it, though gratuitous. Hence, voluntary engagements which are intended to be binding in law should be made by bond or covenant. Secondly, though the sum of money which a person is to oblige himself to pay is a debt already existing, or though any legal consideration for its payment exists, so that a promise by word or by unsealed writing to pay it would be binding in law, yet a bond is a better security; for if the debtor dies before the debt, though due, is paid, the creditor being, by virtue of the bond, among those who are called creditors by *specialty*, will be entitled to be satisfied out of the personal and real assets [Assets] of the deceased, before creditors by *simple contract* (among whom, if he had only the verbal promise or promissory note of his debtor, he would be reckoned) receive any part of the debts due to them. In order, however, that a bond debt may be thus payable out of the *real* assets of the debtor (his lands of which he died seized) before his simple contract debts, the debtor must, by the bond, have expressly bound himself *and his heirs* to pay the debt.

Another advantage which a bond has over a bill of exchange or promissory note is that an action may be brought upon it at any time within twenty years after it is due; whereas a simple contract debt is barred by the statute of limitations after *six* years. [Limitations.]

A bond, though thus a better security in many respects than a promissory note or bill of exchange, is inferior to them in one particular; for it cannot be *assigned* in law, so as to give the assignee the right of suing, in his own name, the obligor for the debt. The courts of equity, however, support, as far as they can, assignments of bonds to purchasers, and acknowledge and enforce the right of such assignees to receive the bond debts out of the assets of the debtors; and the legal difficulty is got rid of by the assignor of the bonds giving the assignee a power of attorney to sue in his name.

A bond is so good a security for the payment of a sum of money, that it is often employed not only when a *debt* is to be established, but when a pecuniary *penalty* is to be provided. When a man is required to oblige himself to do or not to do any act, he often enters into a bond for payment of a certain sum of money, as a penalty in case he departs from his agreement. A bond of this kind, which is called a *penal* bond, is always prepared as follows: It is a simple bond for payment of the penal sum, no time or event being mentioned when that shall be due: but a *condition* is added for making the bond void, in case the obligor performs his duty; the nature of such duty being expressed in the condition. This may seem not to be the most accurate mode of securing a contingent penalty; but, construed by law, such a bond answers its purpose. For though, generally, when a bond for payment of a sum of money mentions no time of payment, an action may be brought upon it immediately; yet in this case the penal sum is not considered to be due or recoverable till the condition annexed to the bond fails of effect by the obligor neglecting or departing from his duty. These penal bonds are further rendered equitable in their operation by the liberal construction which the law puts upon the conditions annexed to them; often holding that such conditions take effect, and that their terms have been sufficiently observed, when, according to a more rigid construction, the penalties would have been forfeited; and often restraining obligees from taking advantage of the failure of such conditions, when they ought not, in justice, to receive the penalties. Even when the obligee in a penal bond is allowed to recover the penalty, he cannot, generally, take any more of it than what is a reasonable compensation for the damage sustained by him; and the amount of such compensation will be ascertained by the verdict of a jury. (8 & 9 Will. III. c. 11.)

The obligor in a penal bond being thus protected, it may seem that equal relief should be given to the obligee, when the penalty is not, as usual, greater than the amount of damage sustained by him, but less. However, it is a general rule, that the obligee cannot recover upon his bond any pecuniary compensation beyond the penal sum expressly secured. But the Courts of Equity consider the condition of every penal bond to be evidence of an *agreement* on the part of the obligor to perform the duty whose performance is to relieve him from the penalty. Thus a condition for making a bond void in case the obligor does or does not do any act, shows, in contemplation of equity, an agreement by him to do or not to do such act; and this agreement will, in many cases, be enforced against him at the suit of the obligee, by a decree for specific performance of the agreement, or by an injunction against its breach; and thus, even where the penalty in a bond is insufficient, the obligee is not always without remedy.

The courts of Law do not consider that an implied *covenant* is created by the condition of a bond, so as to allow the obligee to bring an action upon it; but they, as well as those of equity, so far take the condition to be evidence of a contract upon which the bond is founded, as to hold the bond to be void, if the condition is unlawful. For though, as before said, a bond without consideration may be valid, yet a bond made for an unlawful consideration, or upon an unlawful contract, is void, like every other deed so circumstanced.

Penal bonds have entirely superseded bonds without condition, or *single* bonds; for even when a bond is intended to secure the payment of money, the constant practice is to make it in the form of a bond for payment of a penal sum, double the principal sum which is really to be paid, with a condition, making the bond defeasible upon the latter sum being duly paid with interest. The chief advantage of such a bond over a single bond formerly was, not that more money than was fairly due to the obligee could be recovered under it (for the stat. 4 & 5 Anne, c. 16, forbids that), but that full interest, up to the day on which the debt was satisfied, may be obtained, if within the penalty; whereas, under a single bond for payment of the principal and interest at a certain day, no interest beyond that day could be claimed, until this defect of the law was remedied by stat. 3 & 4 Will. IV., c. 42, s. 28.

A bond is sometimes made by or to several persons together. In such case, the bond may have different effects, according as it is prepared, as either a joint bond, a several bond, or a joint and several bond. This distinction applies equally to covenants, and is noticed under that title. [Covenant.]

The several modes in which a bond may be *discharged* (when not actually satisfied) may also be learned by referring to the same title; where the principal rules relating to the discharge of covenants, which equally apply to bonds, are mentioned.

BONE-ASH (*Bone Earth, Animal Earth*). When bones are strongly heated in open vessels, the whole of the organic or animal matter is burnt off, and a white ash remains, to which the above names are applied. A glance at the following analysis of dried bones, given by Berzelius, will at once indicate the composition of this ash:—

	Human Bones.	Ox Bones.
Animal matter (Osséine)	33·30	33·30
Phosphate of lime, with a little fluoride of calcium	53·04	57·35
Carbonate of lime	11·30	3·85
Phosphate of magnesia	1·16	2·05
Soda, and a little chloride of sodium	1·20	3·45
	100·00	100·00

In addition to the inorganic constituents mentioned in this table, bone-ash contains sulphate of lime produced by the oxidation of sulphide of calcium, the sulphur of which is derived from the animal matter. The principal and only important constituent of the ash is the phosphate of lime, forming from 80 to 90 per cent. of well-calcined bones. It may be separated from most of the other ingredients, and rendered nearly pure, by digesting the ash in hydrochloric acid, filtering, precipitating with solution of ammonia, and well washing the precipitate. Its composition is ($3CaO, PO_5$).

Bone-ash is largely used in compounding artificial manures, as a source of phosphorus, by assayers for making cupels, and in a few other less important operations.

BONE-BLACK (*Ivory-black, Animal-black, Animal Charcoal*). This

substance is manufactured by heating bones in vessels so contrived as to prevent any access of atmospheric air. The bones having been freed from fatty and fleshy matter by long boiling, are heated in a large still or retort made of cast iron or Welsh bricks; it is usually two to three feet square, from fifteen to twenty feet high, and surrounded by a furnace of brick-work. The bones are introduced through an opening at the top, which may be closed by an iron plate; and a steady ignition is kept up for a proper time, convenient arrangements being made for conveying away the volatile products of decomposition. The carbonaceous residue is received through a double trap-door at the bottom of the furnace into cast-iron canisters, which are immediately closed and set aside, that the bone-black may cool. It is then sent into commerce, in a coarsely granulated condition. During the operation the bones lose an average weight of 50 per cent.; some of the matters driven off by the heat are, however, condensed and utilised. [BONE LIQUOR.]

Bone-black necessarily varies somewhat in its quantitative composition; but the following analysis is probably a near approximation to the average amount of its several constituents:—

	Parts.
Phosphate of lime	80·0
Carbonate of lime	5·0
Charcoal	14·0
Carbide or silicide of iron	1·0
Sulphide of calcium or iron	traces
	100·0

Nearly the whole of the inorganic ingredients may be removed by digesting the bone-black in hydrochloric acid, which dissolves them; the residue well washed with water is nearly pure carbon, and is known in commerce as purified animal charcoal.

Bone-black is chiefly used as a decolorising agent in various chemical and pharmaceutical processes; but more especially in the refining of sugar, for depriving the crude syrup of its colouring matter, which is thus better effected than by any other process. M. Bussy, who has paid much attention to this subject, has drawn up the following table, showing the power possessed by various kinds of charcoal of decolorising solutions of indigo and molasses. The indigo solution contained one-thousandth part of its weight of indigo; the molasses was mixed with twenty times its weight of water. The amount of charcoal employed in each experiment was one gramme (= 15·34 grains). The third and fourth columns contain numbers showing the relative decolorising values of the various charcoals, when compared with common bone-black.

KIND OF CHARCOAL EMPLOYED.	Indigo Solution decolorised.	Molasses Solution decolorised.	Comparative Power on Indigo.	Comparative Power on Molasses.
	grammes	grammes		
1. Bone black	32	9	1·00	1·00
2. Vegetable or animal oil charred with phosphate of lime	64	17	2·00	1·90
3. Bone black purified by washing with hydrochloric acid	60	15	1·87	1·60
4. No. 3 calcined with potash	1450	180	45·00	20·00
5. Calcined lamp-black	128	30	4·00	3·30
6. No. 5 calcined with potash	550	90	15·20	10·60
7. Charcoal from carbonate of soda decomposed by phosphorus	380	80	12·00	8·00
8. Charcoal of acetate of potash	180	40	5·60	4·40
9. Starch charred with carbonate of potash	340	80	10·60	8·80
10. Albumen charred with potash	1080	140	34·00	15·00
11. Gelatine charred with potash	1150	140	36·00	15·50
12. Blood charred with phosphate of lime	380	90	12·00	10·00
13. Blood charred with chalk	570	100	18·00	11·00
14. Blood charred with potash	1000	180	50·00	20·00

An attempt has been made to substitute bone-black by common wood-charcoal, artificially impregnated with alumina, phosphate of lime, &c., but without practical success. An excellent decolorising charcoal may also be made by calcining pitch, tar, resin, &c., with hydrate of lime, removing the latter with hydrochloric acid, washing, and drying at a hot-water temperature; but, unlike bone-black, this charcoal, when saturated with colouring matter, cannot have its decolorising power restored by re-ignition.

According to Dr. Stenhouse, decolorising charcoals act either by virtue of their porosity (*e.g.*, purified animal charcoal), by the mordants they contain (*e.g.*, the artificially prepared phosphate of lime or aluminised charcoal), or in both ways, like ordinary bone-black. The inorganic ingredients also fulfil another office; namely, that of separating the particles of charcoal from each other, and thus preventing them from agglutinating, which always takes place when the charcoal is heated alone.

Animal charcoal not only absorbs colouring matters, but to a certain extent deprives infusions of most of the active medicinal herbs, &c., of their active principles, and even takes from solution certain metallic salts.

Ivory-dust, when calcined in the same manner as directed for bones, yields when finely ground a charcoal of a rich velvety-black colour, extensively used as a pigment. The article used largely by blacking manufacturers, and known as ivory-black, is merely finely ground bone-black.

BONE-LIQUOR. When bones are submitted to destructive distillation for the purpose of manufacturing bone-black, liquid products of most intensely offensive odour distil over. This distillate separates into two layers: one forming a heavy, black, tar-like fluid, which constitutes what is known as *bone-oil* (consisting of a complex mixture of hydrocarbons, organic bases, &c.); and another and lighter one, consisting chiefly of a solution of carbonate of ammonia in water. The latter is commonly known as *bone-liquor*, and is much employed for the manufacture of the salts of ammonia, especially the carbonate, sulphate, and hydrochlorate. [AMMONIA.]

BONES have long been extensively used as manure, especially on poor and dry sands and gravels. They have thus become a considerable article of commerce with Germany, Belgium, and Holland, in Europe, and with the chief parts of South America.

Experiments on bones as a manure were made long before their use was extensively adopted, and these, in general, were not attended with a very favourable result, in consequence of the bones not being broken into sufficiently small pieces, or being put upon the land in too fresh a state. But since mills have been erected to crush them to a small size, and the proper use of them has been ascertained, the advantage of this manure in distant and uncultivated spots, where the carriage of common stable or yard manure would have been too expensive, and where it could not be made for want of food for cattle, is incalculable. By means of bones, large tracts of barren sands and heaths have been converted into fertile fields.

The bruising or grinding of bones soon became a distinct business. They were broken into different sizes, accordingly called *inch bones*, *half-inch bones*, and *dust*. Most of the bones procured from London and the manufacturing towns have undergone the process of boiling, by which the oil and a great part of the gelatine which they contain have been extracted. The bones imported from South America have been burned, and are properly bone-ash, the mineral part alone remaining.

At first sight we should be led to imagine, that having lost much of the rich animal matter which they contained, they would be proportionably less effective in the soil. This however does not seem to be the case from the comparative experiments made with bones which have been subjected to either burning or boiling, and those which are quite fresh. All those who have used bones extensively report, that little difference can be observed between them; some even give the preference to those from which the glue has been extracted. But glue forms excellent manure. How is this to be explained? It appears, from the result of many experiments, that bones do not furnish much nourishment to the roots of plants until they have undergone a certain degree of decomposition. The fat and the gelatine, being intimately blended with the bony matter, and contained in cavities or cells, may remain a long time in the earth without decomposition. As a proof of this, it has been found that bones which had lain in the earth for many centuries, on spots where ancient battles were fought, afforded, on analysis, nearly as much gelatinous matter, by the abstraction of the earthy parts, as fresh bones would have done. Bones analysed by Fourcroy and Vauquelin were found to consist of—

	Parts.
Solid cartilage, gelatine, and oil	51
Phosphate of lime	37·7
Carbonate of lime	10
Phosphate of magnesia	1·3
	100·0

The more recent analyses of the bones of the sheep and ox by Berzelius and others are as follow:—

	Thomson.		Berzelius.
	Ileum of Sheep.	Ileum of Ox.	Bones of Ox.
Organic matter (combustible)	43·3	48·5	33·3
Phosphate of lime	50·6	45·2	55·45
Carbonate of lime	4·5	6·1	3·85
			Phosphate of Magnesia.
Magnesia	0·9	0·2	2·05
Soda salts	0·3	0·2	2·45
Potash	0·2	0·1	..
Fluoride of calcium	..	..	2·90
	99·8	100·3	100·00

It is obvious from these, that bones must vary greatly, according to their age and other circumstances.

It would seem, then, that the great effect of bones, as a manure, must depend on the phosphate of lime; and the effect of bone-ashes seems to strengthen this opinion. As to the boiled bones, the more the bone has undergone fermentation, the more soluble its gelatine will

be. In its fresh state it is only soluble in very warm water, and the oil repels moisture. This accounts for the seeming anomaly of the superiority of boiled bones; they have undergone a fermentation. The residue, although not deprived of all its animal matter, is much more porous, and will imbibe and retain moisture in its pores. The food of the plants is here ready prepared and dissolved, and kept in store without being in danger of being washed through a porous soil or evaporated by the heat. All parts of the bone contribute ultimately to the fertility of the soil. Its gelatinous and fatty parts, though a protection to the bone against the destructive action of air and rain-water, are themselves ultimately liable to decomposition, and yield by that process soluble products available for the food of plants. It is in this fact that the value of even fresh bones as manure lies. The explanation of the greater value of bones boiled and even burned, and of bones reduced to powder for manure, lies in the fact that this gelatinous and fatty envelope, though shortly becoming utilised itself, is in the mean time a hindrance to the action of those atmospheric solvents which would reduce the mineral part of the bone to a soluble condition.

It is ascertained that the effect of bones on the crop is much increased when they have been previously mixed in heaps with ashes, burnt clay, or light loam, or made into a compost with the dung of animals, and with vegetable subtances. In this case, the fresh bones will evidently be much more advantageous than those which have been boiled; for the fermentation will extract and decompose the oil and a great part of the gelatine, which, mixed with the other ingredients of the compost, will much enrich them; while the bony residue will be in the same state as it would have been if the bones had come from the boiling-house. By comparing all the facts, we naturally come to the conclusion, that the most economical use of bones is to extract from them the oil and gelatine, which if not of sufficient value for the manufacture of glue or of ammonia, may be used as a supplementary food for pigs, in the form of a broth or pot liquor, which, mixed with meal, will greatly accelerate their growth or increase their fat. For this purpose the bones should be broken in the mill to a moderate size, like those called *inch* bones; they should then be boiled or steamed for several hours, and the liquor strained; this, on cooling, will be found to form an animal jelly of more or less strength, which may be thickened by boiling, and finally dried into a glue or portable soup, which will keep for a considerable time.

The price of fuel and attendance being calculated, it will be seen whether this operation is a real economy or not: if not, the bones may be allowed to ferment in a heap, being mixed with sand or coal-ashes. In this case, they may be ground at once to the size called half-inch; in the other, they may be passed again through the mill after having been boiled.

Till within the last few years the mode of applying bone-manure to the land has been either by sowing from 20 to 40 bushels of them per acre by the hand broadcast, and harrowing them in with the seed; or by putting them into the drills by a machine made for the purpose, which is an addition to the common drilling-machine. This was the most approved method, and the crop for which they are best adapted is turnips, after the land has been well cleaned and tilled. About 25 bushels per acre was sufficient to produce a good crop on poor light sands, and it did not appear that beyond this quantity they had a proportional effect. It is better therefore to repeat the dressing than to put on much at once. When used as a top-dressing for grass-land, they have produced a great and very durable improvement, when the quantity was large.

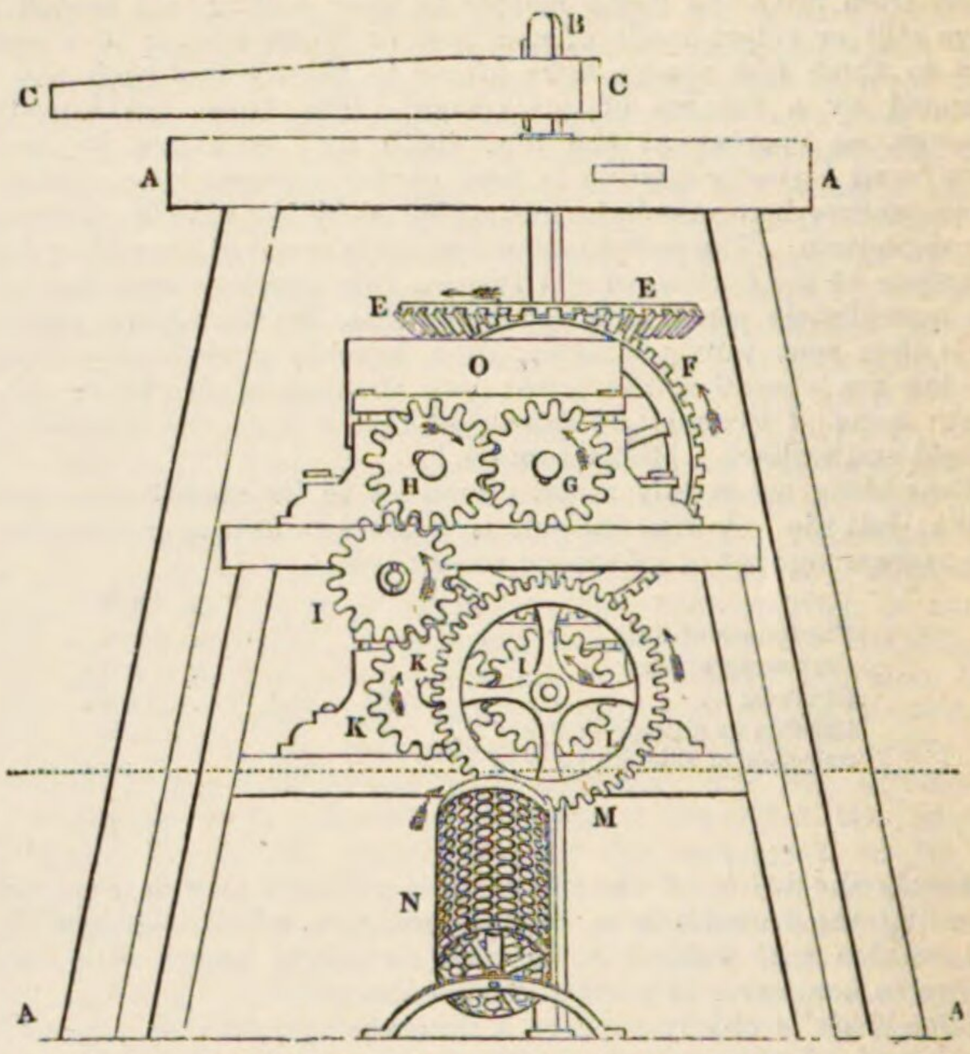
When bones used thus were compared with farm-yard dung the result has been various, and chiefly owing to the seasons and the nature of the land. In strong loams or in very moist seasons the farm-yard dung, put on at the rate of from 10 to 15 tons per acre, had decidedly the advantage, not only for the turnips but for the subsequent crops. On very dry gravelly soils and in dry summers the bones produced the best turnips; and when the comparative cost was taken into consideration, and the saving of time in the light carriage of the bones, the bones proved to be the more economical. Many large tracts of waste land have been brought into cultivation by means of bones, as the only manure which could be procured, and without which they must have remained in a barren state. A great advantage of manuring land with them is that they introduce no weeds, which farm-yard dung inevitably does.

The mill which is used to break and grind bones consists of one or more pairs of iron or steel cylinders, with grooves running round their circumference, the projections being cut so as to form strong teeth. These turn upon one another by means of machinery, so that the teeth of one run in the groove between the teeth of the other, as may be seen in the annexed cut.

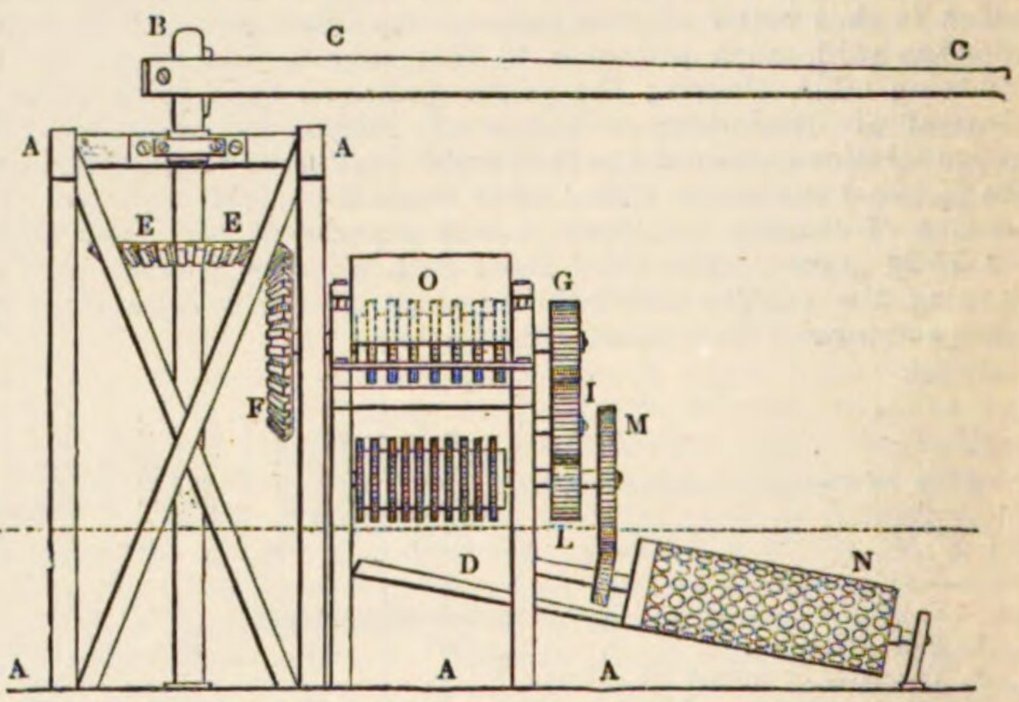
An instrument has also been invented for distributing bones, ashes, rape-dust, and similar dry manures in the drills at the same time with the seed. It consists of a very simple addition to the common drilling machine, and is described under the word DRILL.

The bones put in the hopper O are seized by the teeth of the two upper cylinders and broken in pieces, which fall in between the lower pair, where they are reduced to a smaller size. From these they fall on a slanting board D, and slide into the wire cylinder. All the smaller pieces pass through the interstices of the wire: those which have not been sufficiently broken come out at the end, and are returned into

the upper hopper. Where a machine of this description can be attached to a water- or wind-mill, or to a steam-engine, the bones are



[End elevation of Bone-grinding Machine.]



[Side Plan of the Bone-grinding Machine.]

A A is the frame of a bone-mill strongly fixed to the floor; B the axis of the machinery, which is turned by the lever C C, to which the power is applied; E E is a horizontal wheel with bevelled teeth moving a vertical wheel F, on the axis of which one of the cylinders with grooves and teeth is fixed. At the other end of the axis is a smaller wheel G, turning a similar one, H, on the axis of the other cylinder, making the toothed surfaces turn towards each other, and thus crushing between them the bones which the hopper O supplies. Another pair of cylinders similar to the first, but with smaller teeth, are turned by means of the intermediate wheel I working in the wheel L fixed to the axis on which is a larger wheel M, working in a pinion which turns the cylindrical sieve N. The arrows indicate the direction of the motion.

broken at a small expense; when horses are used the expense is greater; and a hand-mill can only be of use where there is a great superabundance of manual labour, and only a small quantity of bones is required.

When reduced to a dust or rough powder by means of such a machine —the bone is the better fitted to feed the plant, just in proportion to the greater quantity of surface exposed to the action of atmospheric solvents, which is thus conferred upon a given quantity of the material. The finer the dust the more rapidly will it yield its substance to the dissolving action of rain-water; and the more competent therefore is a smaller quantity to supply the demands of a crop. The late Mr. Pusey carried this process to its farthest extent by fermenting bone-dust in a heap with damp ashes, mixed with which it heated and crumbled and ultimately acquired the form of a fine powder. It is evident that 1 cwt. of this powdered bone presented to the action of the air and rain as great an available surface off which to dissolve and carry away whatever food for plants the bone contains, as was presented by many cwts. of rough bones or even of crumbled, so-called bone-dust.

It was accordingly found as the result of this process, that 2 or 3

cwts. of bone-dust thus prepared, produced as great an effect upon the turnip crop, as many bushels of the bones in a cruder rougher form.

The fact appears to be as the result of more modern experience, that while the gelatinous part of bone undoubtedly yields by its decomposition valuable fertilising substances, it is to the mineral part of the material—the phosphate of lime, or rather, its phosphoric acid, which it contains—that its fertilising action is mainly due. Every process, therefore, which has increased either the solubility or the liability to solution of this part of the manure, has increased the rapidity and immediate effect of its application. By reducing bones to powder you increase their liability to solution, for you thereby increase the surface wetted by the rain-water. Rain-water contains carbonic acid, and by this acid the phosphate of lime acquires a soluble form, and is ultimately presented liquid to the absorbent roots of plants.

But this solubility can be conferred upon it directly. It was Baron Liebig who suggested that a similar process to that by which soluble phosphoric acid is obtained from bones in the process of manufacturing phosphorus, might be available in the manufacture of a valuable manure. If sulphuric acid be added to bone-dust, the latter becomes to some extent decomposed. A portion of its lime is taken from the phosphate of lime in the bone, and unites with the sulphuric acid; the phosphoric acid of that portion of the phosphate which has been decomposed, unites with the portion of phosphate which has been left undisturbed, and forms a superphosphate; and this is soluble in water. It is the proportion of the resultant manure which is thus rendered soluble that is the measure of the immediate energy and value of the so-called "superphosphate," which is thus prepared for sale and use. Every manure maker now prepares a superphosphate—and a good manure of the kind should contain at least 15 per cent. or more of the soluble superphosphate, and 15 per cent of the neutral, or natural bone phosphate, together with a small proportion of ammonia, resulting from the gelatinous part of the bone-dust. Where the *mineral* phosphate of lime, coprolite, or apatite, is used in the manufacture, the neutral phosphate left unacted on by the acid is useless as a manure. Where bone-dust is the source employed of the phosphate of lime, then of course, that portion left unacted on, retaining its natural cellular structure, is still liable to the natural influence of atmospheric solvents, and will continue gradually to dissolve and yield food for plants. In both cases, however, it is the quantity already reduced to a soluble state, which is the measure of the immediate value of the fertiliser. This effect is not due to any power which the manure has thus acquired of at once entering the roots of plants, because the immediate effect of the contact of a soluble superphosphate with the earths present in the soil, is to cause it to resume its original condition of neutral, and therefore comparatively insoluble phosphate of lime. Having, however, once been in a state of solution, it retains in its precipitated state, a condition of so much finer division than any mechanical means could give it, that the superphosphate is as rapid in its action on the crops to which it is applied, as if it retained its solubility throughout.

The effect of this manufacture of superphosphate on the farm practice of the country has been greatly to alter the method of applying bone-dust. Formerly, 24 bushels of bone-dust were applied for the turnip crop per acre—and upwards of one ton per acre was applied in Cheshire to pastures. Now, 3 or 4 cwts. of superphosphate are applied per acre to the turnip crop with an even greater effect.

A good superphosphate as now manufactured ought to contain 18 to 20 per cent. of the soluble phosphate, and 10 to 15 of the neutral phosphate, and from 1½ to 2 per cent. of ammonia. Such a manure is well worth 7*l.* a ton. It is applied almost exclusively to the turnip crop; being drilled in before the seed—or scattered broadcast before the land is ribbed up to receive the seed. The ordinary application is 3 or 4 cwts. per acre, with a half dressing of ordinary farm manure. It is less useful as a manure for corn crops of any kind; but for green crops, and especially the turnip, it is unrivalled.

BONNET, a name sometimes applied, in permanent fortification, to a work consisting of two faces forming a salient angle which was employed to cover the angle of a *ravelin* when the faces only of the latter were protected by *tenaillons* or *lunettes;* the fire from the bonnet defends the fronts and salient angles of the tenaillons, and the faces of the former work are reciprocally defended by those of the latter. [TENAILLON.] When the parapet about the salient angle of any work, as a bastion or ravelin, is raised above the general level of the faces of the work, the elevated part is now occasionally called a bonnet.

BONNET DE PRÊTRE was a term in field fortification, applied by the French engineers to an indented line of parapet having three salient points, on account of some supposed resemblance to the object from which it was named. [REDAN.]

BONZES is the name by which the priests of Buddha are usually designated in Japan. The form of the name in the Japanese language is *bonsan,* which word is supposed by Mr. B. H. Hodgson ('Journal of the Royal Asiat. Soc.,' 1835, vol. ii.) to be a corruption of the Sanscrit *bandya* (*vandya,* 'laudable, deserving praise'?) They go with their heads entirely shorn, whence they are often ironically called *kami-naga,* or "long-haired men." The highest in rank is the daïri, or spiritual sovereign of Japan, who resides at Miaco. Till towards the conclusion of the 12th century (A.D. 1185) the power of the daïri in Japan was nearly absolute; since then the supreme government has become vested in the djogoun, or secular commander-in-chief of the empire, and the influence of the daïri in temporal affairs is now next to none, though he still continues to enjoy the honours of a merely nominal sovereignty. (Titsingh, 'Illustrations of Japan,' translated by F. Schobert, London, 1822, 4to.)

The Bonzes are under a vow of celibacy, and form a large corporation of male and female ecclesiastics. They are divided into sects, hostile to each other, and externally distinguished by the colour of their robes. They maintain their influence chiefly by the popular belief in the efficacy of their intercession for others by prayer. Once in every fortnight they deliver a public religious discourse in the temples, usually before numerous congregations. The Jesuit missionary, Gaspar Villela, who attended several public meetings of this kind, speaks in high terms of the eloquence of the preachers whom he heard, and of their impressive and dignified mode of delivery. Even the female Bonzes are said occasionally to preach.

The Japanese priesthood comprises individuals of all ranks of society. Persons of high birth, even the sons of kings, are known to have entered the order of Bonzes, but the majority belong to the lower and poorer classes. Many Bonzes earn their livelihood by superintending funerals. All claim it as the exclusive prerogative of their order to speak upon the religion of Buddha, the doctrines of which they will not allow to be touched upon by any one else. The principal moral precepts which they inculcate are five, namely,—not to kill, not to steal, chastity, veracity, and abstinence from spirituous liquors; but there are esoteric, as well as exoteric, doctrines held and taught, the mass of the followers being chiefly instructed as to certain formal observances and ceremonies.

There are convents for the male as well as for the female Bonzes, some of which have their own fixed annual revenues, while others are maintained by voluntary contributions from the people. The discipline enforced in these convents is described as rather strict. At different hours during the day the sounding of a bell summons the inmates to their common devotions. In the evening the prefect assigns to every one a special theme for his meditations. After midnight all assemble to sing hymns before the altar. Their meals they take in common, and those who conform strictly to the rule abstain from meat and fish, as well as from wine and all spirituous liquors. Some of the convents are said to contain large libraries.

Gemelli, who visited China in 1695-6, speaks of the three religious sects in that kingdom, and accuses the Bonzes of Buddha of idolatry, and calls them "a pernicious sect," but acknowledges that they teach the soul's immortality and a future state of rewards and punishments. He says theirs is the religion of the commonalty and "the baser sort." He states, also, that they had the greater number of wealthy and beautiful temples as pagodas, and that there were 350,000 who had patents, while the whole number would amount to a million, and that in Pekin there were 10,568 who had no wives, for one of their doctrines was the superiority of celibacy,—and 5022 who were married. Sir John Davis ('The Chinese,' vol. ii.) states that they teach a species of metempsychosis, till the soul is absorbed into nonentity, but that they are not strictly speaking idolaters, as they sacrifice to the invisible spirit, and not to the representation of it in the idol,—a distinction apt to be confounded by their less intelligent followers.

In Siam and Tibet, where the worship of Buddha also prevails, the priests are distinguished in the first as TALAPOINS, in the second as LAMAS.

BOOKBINDING. When books were merely groups of leaves, either of thin skin or some kind of vegetable membrane, the art of the bookbinder was a very primitive one. He had simply to paste or glue the leaves together, so as to form an extended sheet, and to attach this sheet to a cylinder round which it might be rolled. Even to the present day it is customary in some Oriental countries to write on slips of vellum, to sew these slips together into one long sheet or page, and to attach this sheet to rollers at each end, clasped with gold or silver. The square form of binding, now so well known, was of later date, and constituted a very marked improvement; it was adopted largely for the written missals used in Roman Catholic countries, long before the invention of printing, and has been retained as the most convenient mode of binding.

In the binding of a book at the present day, whether humble or costly, there are generally three classes or successive stages of operations, varying in detail according to circumstances, but following each other pretty nearly in regular order. These relate first to the grouping of the sheets together, in a uniform and symmetrical way; next to the fixing of the stiff covers or boards which give firmness to the book; and lastly to those processes which relate rather to the external beauty than to the strength or efficiency of the book. These we shall designate as—1. *Preparing;* 2. *Binding;* 3. *Finishing;* and shall notice the chief varieties as we go on.

1. *Preparing.* A book is built up of several sheets, each folded and re-folded so as to assume a more convenient size than as originally printed. The number of successive foldings depends on the size of the work; thus octavo or 8vo, implies that there are eight printed pages on one side of a sheet, and that the sheet must be so folded as to be brought to one-eighth of its original size. The number whereby the size of a book is designated expresses at the same time the number of printed pages obtained from one side of a printed sheet, such as folio, 4to, 8vo,

12mo, 16mo, 18mo, 24mo, 32mo, &c. In folio there are only 2 pages on each side of a sheet; the others have 4, 8 &c. Some of the sheets employed are larger than others: thus royal octavo, though folded into the same number of pages as post octavo, is larger in size, in consequence of the sheet of paper being larger.

The folding of the printed sheets is one of the first operations in preparing for the binder. Each sheet has a letter at the bottom, such as A, B, &c., for identification; and there are as many of these letters, called signatures, as there are sheets to form the volume. When the alphabet is in this way exhausted, another in smaller type, or duplicate letters, or letters combined with numerals, are employed. There is a heap of signature A, another heap of signature B, and so on. The folder sits before a bench, on which each sheet is spread out in sucession; and the folding is aided by the use of a bone or ivory folding-knife: it is done with great rapidity, and with an accuracy which can only result from constant practice. In some establishments a folding-machine has been introduced. The folded sheets are gathered into new groups, fitted to make up into books; that is, each new group is made to contain one copy of the sheet bearing signature A, another of signature B, and so on. The groups are next collated, that is, examined throughout to see that no mistake in the order of arrangement occurs.

If the sheets thus folded, gathered, and collated, are to be put into boards, they are sewn in the next process; but if they are to be bound, and therefore finished in a more careful manner, they are beaten or pressed before being sewn, as a means of bringing them to a more compact and smooth state. Until a recent period this process used to be effected by means of the hammer—the volume being divided into parcels of a few sheets; and these parcels, held flat on a smooth stone, being beaten with a heavy hammer. But the rolling-press has greatly improved the mode of proceeding. This press consists of two smooth steel rollers, rotating nearly in contact; the parcels of a volume are placed between tin plates and then passed between the rollers, the action of which gives them a more effective and expeditious pressure than the hammer. Sometimes, however, the ink becomes 'transferred' to the opposite page by this process, when not properly conducted—to the great disfigurement of the book.

In sewing together the sheets for a volume, they are not actually fastened one to another, but all are in common attached to a range of parallel strings or bands placed across the back of the volume. Sometimes marks are cut with a saw across the back edges of the sheets, to receive the strings; but in other cases these saw-cuts are dispensed with. The process of sewing is carried on by the aid of a sewing-press, which consists of a flat bed or board, two upright bars rising from the ends of this, and a cross-bar at the top. The strings are fastened to the cross-bar and are stretched vertically downwards to the bed of the press, where they are firmly secured. The number of these strings depends principally on the size of the book, and varies from two to eight or ten. The sewer (a female) sits in front of the press, lays a folded sheet down on it, with the back edge in contact with the strings, opens the sheet in the middle, and sews it to the strings, passing a needle and thread to and fro. The needle passes through the back edge of the sheet twice as many times as there are strings; the object being to twist the thread round every string, and thus connect them and the sheet together. The first sheet having been thus treated, a second is laid on the first, and sewn in a smilar manner; and so on with a third, a fourth, and as many as there are to form the volume—all the threads being fastened to all the strings, and, indirectly, to each other; for the thread passes from one sheet to another by a peculiar kind of stitch called a 'ketch' stitch.

Binding.—The sheets are by the sewing-process brought together into a book-like form, and are then ready to pass through the operations connected with the boards and covers. The back-edges of the sheets are glued together, to increase the strength of the volume: this is done by simply holding the book in the left hand, and brushing on it a little warm melted glue. The glue being dried, the ends of the strings (which are allowed to hang loose for an inch or so beyond the volume) are scraped thin, for the sake either of being rendered invisible when the book comes to be bound, or else to aid in fastening on the boards. The volume is next rounded in a singular manner; that is, rendered convex on the back and concave or hollow on the fore-edge. The workman lays the volume down flat, and beats it with a hammer held in his right hand, while the left draws the sheets in such a way as to produce the rounding of the edges: the manipulation is a curious one; and as the glue is not yet quite dry, the sheets are enabled to yield a little to the action of the hand and hammer.

A groove is now made to receive the boards or stiff covers. These boards would project beyond the width of the back edge, and would be both unsightly and inconvenient, if some means were not adopted for compressing or confining them. A thin bevel-edged board is placed on each side of the volume far enough from the back edge to allow of a kind of ledge to be formed; these backing-boards, as they are called, are placed parallel with the back edge; and the volume, with these boards on either side, is lowered into a press, with the back edge uppermost. By hammering this edge in a particular way, it is made to expand or spread out, and thus to form two ledges against which the covers of the book are to be placed. Although in common language we consider the covers of a book to be the stiff sides which keep

it firm and compact, yet the terms applied by a bookbinder are rather different. With him, this stiff envelope is called the *board*, the leather or cloth applied outside the board is the *cover*, and the two together form the *case*; and it will be convenient to retain the same terms here.

If the book is to be *boarded*, to use a familiar term, the edges of the leaves are not often cut; but if it is to be bound, this cutting of the edges is an essential process, and is done before the boards are fitted to the volume. The cutting is thus effected: The volume, placed between two boards, is screwed in a press; one of the ends of a volume being left projecting a little above the press. A cutting instrument, called a plough, partaking in some degree of the action of a carpenter's plane, is passed over the end of the volume so as to shave off the ragged edges of the sheets, and leave them perfectly smooth. The volume is reversed in position, and the same thing done with the other end. It is then taken out of the press, and struck forcibly against a bench, so as to bring the convexity of the back and the concavity of the front edge alike to a plane level, which admits of the front edges of the leaves being cut in the same manner as the top and bottom edges had been. The book springs back again immediately on being released from the press: and then presents the neat appearance which a concave front edge, convex back, and plane top and bottom edges, are calculated to give.

Matters are now ready for applying the stiff boards. These are made of millboard, a smooth brown or drab-coloured pasteboard made of several layers of paper glued together and strongly pressed. The sizes and thicknesses vary according to the size of the volume and the kind of binding for which they are to be used. The boards are cut very quickly from the large sheets by a cutting edge applied nearly in the same way as in tobacco-shredding or in chaff-cutting. In attaching these boards to the book, the strength of the fastening depends on the kind of binding. If the book is to be bound, holes are made through the boards, opposite to the strings; and the loose ends of the strings, being passed through these holes, are glued down firmly to the inner surface of the boards, thereby forming a very firm fastening. If, on the other hand, the volume is to be in "cloth boards," the strings are not generally passed through and glued down in this way, but the boards are fastened to the book chiefly by being pasted to the blank leaves or end-papers placed at the beginning and end of the book. These boards, in this latter case, are brought somewhat to a finished state before being attached to the volume; for the cloth is cut to the required size, and handed over to a workman who pastes it upon the two boards, placed sufficiently wide apart to allow for the thickness of the book. Some books, especially in the present day, are made hollow in the back; which is thus produced: A double layer of paper or of cloth is placed between the leather of the cover and the back of the sheets; the leather is glued to the outer layer, and the back edge of the sheets to the inner layer; and as the two layers are connected at their edges, but detached or loose from each other at their surfaces, they give a kind of hollowness to the back of the book.

Most well-bound books have a little appendage at the top of the back-edge, called the head-band. This gives a neat finish to the book, and at the same time strengthens the leather covering of the back-edge at that part. For common books the head-band consists of a cord inserted in silk or cotton; but for better work it consists of a little strip of vellum or pasteboard, around which coloured silken threads are twisted by the same process as that which fastens it to the volume.

When the volume is done in cloth of one uniform colour, the cloth cover is applied to the boards before the latter are attached to the volume; but when it is whole-bound, having leather all over the outer surface, or half-bound, having partly leather and partly paper or cloth at the surface, these coverings are put on after the boards are attached to the book. The leather is cut to a size rather larger than the book, to allow for paring and turning in, and is laid face downwards on a smooth board. The back of the leather is well pasted, and the book placed down upon it, the hands of the workman drawing, and adjusting, and pressing the leather, until it adheres closely to the book in every part. If half-binding be the style of work, then the leather is so cut as to cover the back and a small portion of each board or side; while four small pieces are applied to the corners. The paper or cloth is subsequently so pasted on as to hide the ragged edges of all these five pieces of leather.

Finishing.—By the processes above described, the book has received all which is really necessary for service; the sheets have been arranged in proper order, sewed to strings, fastened to boards, and covered with cloth, leather, or paper. But a large portion of the talent, the ingenuity, and the capital applied to this branch of manufacture is called forth by the subsequent processes to which the book is subjected. These must be rapidly glanced at.

First, with respect to the *edges*. Most persons who purchase books are aware that, if in boards, or cloth-boards, the top edges of the sheets, although placed level, are uncut; while the fore and bottom edges are ragged, uneven, and uncut. In some cases, to make a nearer approach towards neatness, the fore-edge only is cut; in occasional instances, too, the whole of the edges are cut, but left white. But a white edge to a book would soon become discoloured and unsightly; and it is far more usual either to sprinkle the edge with colour, or to

gild it. In sprinkling, the edges of several books are laid on a level one with another, and a piece of sponge, dipped into liquid colour, is passed lightly over the edges, so as to impart the tint to them regularly; this is called *colouring*. A more general method is that of *sprinkling*. The books are in this case ranged side by side on a bench, and a brush dipped in the liquid colour (which is formed of some such pigments as Venetian red, umber, &c.) is held over the books, and lightly tapped against a stick, whereby a shower of spots falls on the edges of the books, producing an appearance depending on the colour employed, and the manner in which the shower of spots is brought about. *Marbled* edges are sometimes produced, by a peculiar admixture and management of different colours sprinkled on the edge of the book.

Gilt edges are more delicate in their preparation. The gold so applied is in the same state as for various ornamental purposes, namely, an extremely thin leaf. Before the case or cover of the book is quite finished, the volume is struck forcibly against the back, so as to make the fore-edge flat instead of concave. It is then placed in a press, with the exposed edge uppermost. The edge is scraped smooth with a piece of steel, and is coated with a mixture of red chalk and water. The gold is blown out from small books, and spread on a leather cushion, where it is cut to the proper size by a smooth-edged knife. A camel-hair pencil is dipped into white of egg mixed with water, and with this the partially dry edge of the book is moistened; the gold is then taken up on a flat kind of brush, and applied to the moistened edge, to which it instantly adheres. When all the three edges have been gilt in this way, and allowed to remain a few minutes, the workman takes a burnisher formed of a very smooth piece of hard stone, and setting the end of the handle against his shoulder, rubs the gold forcibly—not (as might be supposed) endangering its permanence, but giving it a high degree of polish, by rubbing down the minute asperities which may be occasioned by the paper beneath. The gold employed has a greater or less degree of solidity according to the costliness of the book.

The covers have next to be noticed, beginning with those of *leather*. The leather so employed is roan or sheep, calf, Morocco, and Russia; at least, these are the principal kinds, to which alone we need make allusion here. These kinds of leather receive their colour at the dye-houses in Bermondsey, where they are prepared in vast quantities, not only for the London market, but for many other parts of England; but "roan-bound" books, such as school-books, are often sprinkled with colour by the book-binders after the leather has been attached to the boards. For this purpose, the books are opened, and hung over two bars in such a manner that the leaves may hang vertically downwards, while the boards lie horizontal. A brush is dipped into the liquid colour, and dashed or sprinkled on the cover so as to give a group of spots or wavy lines, at the taste of the workman. Calf and Russia leathers do not often receive any modification of surface from the bookbinder; but Morocco is sometimes treated in the following manner. The Morocco leather employed for chair-covers and such purposes is made either of kid-skin or sheep-skin according to its quality, and has a wrinkled appearance, arising from the surface having been rubbed very hard with a minutely grooved piece of wood. Now for many purposes of bookbinding these wrinkles are changed to a granulated appearance, by the following process: Two pieces of leather being well wetted, and laid face to face, the upper one is rubbed in different directions with a flat piece of cork, by which the wrinkles are removed, and a slightly granulated texture produced.

The decorations produced on a leather-bound book by heated stamps or dies are very diversified. The dies for producing any particular device are fixed to handles, and when about to be used are warmed in a gas-heated stove. Many such dies are often used for one book, and the process of producing a sunken ornamental device by using these tools by hand is called blind-tooling. But for many purposes it is more convenient to fasten a great number of small dies as partial devices to a metallic plate, by means of glue and cloth, and to stamp the device from this fixed plate by means of a press; this is called blocking.

All the devices so produced on a book are called "blind," if no gold be employed; but much of the beauty of the workmanship depends on the tasteful introduction of this metal in forming part or all of the pattern. The leather, as laid on the book, is not in a fit state for receiving the gold without some modification of surface. It first receives a coating of parchment-size; then two or three coatings of white of egg, whereby a slight glossiness is produced; and just before the gold is to be laid on, the surface is slightly moistened with oil. The gold, cut up into small pieces, to suit the kind of ornament, is laid on the book with a flat camel-hair brush; and the stamp or die, previously heated in the fire, is impressed on the gold; whereby two effects are produced at once—the production of the device, and the fixing of the gold to the leather. A piece of soft rag, lightly passed over the book, removes the small superfluous fragments of gold, and leaves the gilt device clearly marked.

But the decoration of volumes bound in cloth, although occupying a far lower level in respect of manual dexterity than the more costly binding in leather, has occupied much attention within the last few years, and has been one of the means for producing neat and even elegant volumes at a marvellously low price. Cloth-binding, in fact, has been the germ of one great advance in the art—the application of machinery to much that had previously been effected by manual labour.

The cloth with which books are covered is generally cotton of a particular kind, woven for the purpose. When the system of cloth-binding came up, about thirty years ago, the cloth was used in the unaltered state, with the warp and weft threads visibly crossing each other at right angles. But now the cloth is more generally so altered by an artificial embossment of surface, as to leave the threads barely visible, and to give to it a close resemblance to leather. The cloth covers for many books have now imparted to them, by embossing, a remarkably close resemblance to the appearance of leather; a resemblance which, though now becoming very common, would have deceived many an eye a few years ago. This embossing is produced by drawing the cloth, while yet uncut for the purposes of binding, between two steel rollers, of which the surfaces are engraved with the required device, and which have a row of gas-jets through their hollow centre, to keep up a constant temperature. There must be as many pairs of rollers as there are different devices for embossing cloth; so that the number in large factories is very considerable. Some of the rollers are intended for the production of a uniform device over the whole surface of the cloth; while others have particular devices for each particular book, and are consequently planned with especial reference to the size of the volume. The rapidity with which books can be now bound in this way, is one great cause of the surprising cheapness at which they are often sold. Paper-wrappers for stitched but unbound books can of course be applied much more quickly. One of the most notable examples of this kind ever known, was afforded by the Great Exhibition of 1851. At ten o'clock in the evening of the 30th of April, the first complete printed copy of the Official Catalogue left the printer's hands; in the following forenoon *ten thousand* such copies were ready at the Exhibition building in Hyde Park, including two superbly bound, for Her Majesty and Prince Albert.

Other kinds of cloth covers, especially those which are much decorated with gold, are stamped with the device *after* being pasted on the covers, instead of before; they are, in fact, *cases*, each one quite ready to affix to the book in a speedy manner after being stamped. Great pressure is required in this process, for the mill-board is required to yield to the force, as well as the cloth itself. The case is placed down flat on an iron bed heated with gas from beneath; above is a press, to the lower end of which is attached the stamping-die or device, face downwards. Great mechanical power is then brought to bear on it, and the press descends with force sufficient to impart the pattern to the cover, gilt or not, according to the circumstances of the case.

India-rubber Binding.—The last few years have witnessed the introduction of a singular mode of binding, arising out of the use of a cement or glue of caoutchouc, instead of sewing, for fastening the sheets of books together. In this process, the sheets are not allowed to retain the folded form customary in other kinds of binding; but the edges are cut on *all four* sides—on the back as well as the front, top, and bottom; the consequence of which is, that all the leaves are separated one from another. The group of leaves to form one volume is placed in a kind of gauge, by which convexity is given to the back-edge and concavity to the front; and a cement of caoutchouc is carefully applied to the back-edge, whereby all the leaves become cemented together. The subsequent operations are much the same as in other binding. There is a certain kind of flexibility resulting from this method, advantageous when the volume is thick. This method was introduced by Mr. Hancock, and in reference to it the late Dr. Ure remarked:—"For engravings, atlases, and ledgers, this binding is admirably adapted, because it allows the pages to be displayed most freely, without the risk of dislocating the volume; but for security, three or four stitches should be made. The leaves of music-books bound with caoutchouc, when turned over lie flat in their whole extent as if in loose sheets, and do not torment the musician like the leaves of the ordinary books, which are so ready to spring back again. Manuscripts and collections of letters which happen to have little or no margin left at the back for stitching them by, may be bound by Mr. Hancock's plan without the least encroachment upon the writing. The thickest ledgers thus bound open as easily as paper in quire, and may be written up to the innermost margin of the book without the least inconvenience."

A method was patented, some years after the introduction of india-rubber binding, under the name of "Cement-binding." This consists in cementing the leaves or sheets together at the back, with a composition of isinglass, oil, sugar, and other ingredients; and in covering the cemented edges with a strip of calico similarly cemented. What advantages (if any) this possesses over the caoutchouc binding, does not appear: its principle is evidently the same.

Palmer's patent binding consists in applying small brass bars, linked together, to the back of the book, in such a manner that they make the different sections of the book, when open, parallel with each other, and thus admit of writing readily on the ruled lines near the back. It seems to be another mode of attaining some such result as that which is aimed at in india-rubber binding.

Williams's patent binding consists in the employment of a back, curved in form, turned a little at the edges, and made of metal, ivory, or wood. This back is adjusted to the book before it is bound, in such a manner that it may just cover but not press upon the edges, and is fastened on by enclosing it in vellum or ferret wrappers, which are pasted down upon the boards, or drawn through them. The object is

to make the book open freely and evenly, and to prevent it from spreading on either side.

There have been other recently-patented novelties in book-binding; but instead of dwelling upon them, we will make a few observations on the condition of the art generally.

The finest specimens of modern book-binding ever seen in this country were probably those in the Great Exhibition of 1851. The Report of the Jury on "Paper and Books," noticed the attempts which have been made to adapt the style of book-binding to the subjects of the books. Those attempts have in some cases been directed to particular colours of the leather or cloth; but more generally the style of ornament has borne relation, real or supposed, to the subject-matter treated in the volumes. For example: characteristic emblems or symbols have been adopted among the gilt or stamped adornments; and ornaments of Egyptian, Roman, Grecian, Gothic, or Saracenic character have been used in works relating to the history or geography of those countries. It is generally admitted, however, that our bookbinders do not attend much to this subject. The Jury gave the following interesting notice of some of the steps whereby the rapid book-binding of modern times has been rendered possible:—"Mr. Burn, of Hatton Garden, first introduced rolling-machines to supersede hammering. The iron printing presses of Hopkinson and others were altered to form arming-presses, by which block-gilding, blind-tooling, and embossing can be effected with accuracy and rapidity. Leather covers, embossed in elaborate and beautiful patterns by means of powerful fly-presses, were introduced by M. Thouvenin, of Paris, about twenty-five [now nearly thirty-five] years ago; and almost simultaneously in this country by Messrs. Remnant & Co., and by Mr. De la Rue, who were quickly followed by others. Embossed calico was also introduced about the same period by Mr. De la Rue. Hydraulic presses, instead of the old wooden screw presses; Wilson's cutting-machines, which superseded the old plough; the cutting-tables with shears, invented by Mr. Warren de la Rue, and now applied to squaring and cutting millboards for book-covers,—all these means and contrivances, indispensable to large establishments, prove that machinery is one of the elements necessary to enable a binder on a large scale to carry on that business successfully."

Before closing this article, it will be desirable to notice briefly some of the points treated in an interesting paper read before the Society of Arts, in February, 1859, by Mr. John Leighton:—'On the Library, Books, and Binding, particularly with regard to their Restoration and Preservation.' Dust and dirt upon books in a library affect the binding in a way that may easily be understood, and needs no comment. Dampness occasions the frequent disfigurement of books, both in the paper and the binding, with spots like iron-moulds, which will ruin the volume if left unremedied. Dry heat is even worse than damp for the leather of binding. In the library of the Athenæum Club, the calf and Russia bindings were found some years ago to have suffered so severely, by the effect of a gas-lighted room, that in many cases they crumbled under the touch, the backs fell away, all the oily matter seemed as if dried out of the leather, and a general deterioration was visible. Mr. Faraday, to check the spread of the evil, introduced a gas-burner with a chimney for conveying the deleterious fumes to the outer air; but Mr. Leighton expresses an opinion that it is better in all cases to use oil-lamps in a library—so far as the books are concerned. In old libraries, the ravages of a peculiar kind of bookworm are well known to bookbinders and bibliopolists. An instance has been recorded where, in a range of books very seldom consulted, twenty-seven adjacent folio volumes were found perforated by a wormhole, so direct and thorough that a string could be passed through the whole thickness of all the volumes, paper and binding included. Some kinds of leather suffer more than others from insects and worms; and in hot countries, the paste and glue of ordinary bindings become unfortunate sources of destruction. Mr. Leighton thinks that modern ordinary mill-board, made of well-tarred rope, is as good a material as can be found for the groundwork of book covers; he makes some useful comments on the often-suggested use of corrosive sublimate, colocynth, starch, alum, vitriol, salts of ammonia, orpiment, and other substances, as preservatives of books against insect-visitations; and he hints that an occasional atmosphere of tobacco-smoke may be useful in this matter. Mr. Leighton made the following observations on the chief kinds of leather used in bookbinding:—"Many books of the mediæval period are bound in vellum and leather, without millboards. Formerly a pasteboard was used, made of the rudest materials—paper, cloth, old vellum, or what not. The earliest leather covers were principally of a rich brown calf, undyed; and so they remained until the early part of the present century. All the stains then in vogue were imparted to the skin by the bookbinders; who, by the judicious application of them, produced very beautiful natural effects—tree marbles, sponge dabs, sprinkled and spotted patterns—innumerable, though not always without injury to the leather, the surface of which the stronger acids were apt to burn after some years' action. The plain dyes given to calf in the whole skins have tended to supersede the colouring of leather on the volume itself. The old, simple, undyed calf was exceedingly good and strong; being more durable than many of the fancy-hued hides of the present day, which seem to have the elements of decay therein before being put on the volume, and which are even afterwards washed by the binder with oxalic acid, imparting a delicacy of surface most injurious to the skin. This is clearly evidenced in the binding of law-books, uncoloured calf being always used (which, in combination with the white edges, is, I believe, intended as typical of the purity of the profession); the leather being washed up with spirit to a fictitious whiteness, rendering it in a few years rotten, as many law libraries will sadly testify. Morocco, the earliest coloured old leather, is decidedly the strongest, richest, and best for the binder's art; it is surface-dyed goat's skin, and no doubt first came to England on Venetian books, when that Republic was in its glory. It is the prince of leathers; having received the greatest and choicest amount of decoration, the most delicate and boldest of hand-tooling. Hog-skin is a nice and durable material for bookbinding, though not much used; it takes blind-tooling admirably. Russia, unless used extremely thick, is a poor and rotten leather; being little stronger than paper if pared thin, and only to be prized on account of its odour, and pleasant tint of colour. In bookbindings of the present day, leathers are pared and shaved much too thin, especially where strength is most required—at the joints, near the head-bands; this is by no means necessary, if the leather be turned in the entire thickness, space being cut for its reception in the board—a plan I have always adopted for heavy books. Vellum is extremely strong and useful to the binder, though from its rigid nature hardly adapted to book-joints—at least, as books are bound or forwarded (as it is termed) at present; unless it be those of account-books, where all strong materials, from hard writing-paper to horny bands of leather, are most prized. Vellum bookbinding for bankers, &c., is a distinct branch of trade, apart from bookbinding proper; in the binding of printed books it is somewhat difficult to get a whole vellum cover to set well, it being a material better suited to immoveable parts, as edges, corners, linings, and inlayings." In a discussion which followed the reading of Mr. Leighton's paper, it was stated that the bound books of the London Institution, of the library of the Earl of Tyrconnel at Kilpin, of a room in the 'Times' office, of the Royal College of Surgeons, of the Literary and Philosophical Society at Newcastle on Tyne, of the Alfred Club, and of the libraries belonging to other individuals and corporate bodies, had all suffered in the same way as those at the Athenæum Club, by the use of gas-lights or gas-stoves.

BOOK-KEEPING. Book-keeping by double entry is the art of keeping accounts in a scientific manner.

So much obscurity surrounds the early history of the art that it is impossible to discover either by whom, or at what period, it was invented. Some are of opinion that it was known in Europe as early as the beginning of the first century, but the passages in the classical authors are inconclusive on which this opinion is based. Others assert that it has been practised by the Banians of India from time immemorial, and that it was by them communicated to the Venetians in the 15th century; while others again say that the Venetians learned it from the Arabians. However this may be, it is certainly to the Venetians that we are indebted for our knowledge of the art. The earliest known treatise on the subject is that of Lucas de Burgo, which was published in the Italian language in the year 1495, from which circumstance book-keeping by double entry has acquired the designation of the Italian method.

Italy—at this period the great centre of the world's commerce—evidenced its appreciation of the art, by producing several works on the subject in quick succession. In the beginning of the 16th century the art was introduced into France; and in the year 1543 Hugh Oldcastle, a schoolmaster, published the first treatise in this country.

More than one hundred and fifty works on book-keeping have been published in the English language since that by Hugh Oldcastle, but the number of those which merit unqualified praise is not large. The earlier works, indeed, were extremely crude and unsatisfactory; and it was not till the year 1789, when Mr. Benjamin Booth, a merchant of intelligence and experience, published his 'Complete System of Book-keeping,' that we could be said to possess a thoroughly practical exposition of the principles of the science.

The theory of double entry has been repeatedly assailed both in this country and on the continent, and by none more ably than by Mr. Edward T. Jones, an accountant of Bristol, who first attacked it soon after the appearance of the work by Mr. Booth, to which we have just referred. Mr. Jones's object was two-fold—first, to overthrow the Italian system, which he contended was fallacious, and secondly to establish in its stead a system of his own invention, which he represented to be infallible. The method recommended by Mr. Jones is known as the English system of book-keeping.

Mr. Jones's announcement excited considerable attention in the commercial world, and resulted in a large subscription being raised for his encouragement. In the year 1796 a patent was granted to him for his invention.

The expectations raised by that invention, however, were not fulfilled; and although Mr. Jones has left us two greatly enlarged and improved editions of his original work, the Italian method has maintained its ground as the favourite method of book-keeping, and is still employed by the first merchants of Europe and America.

It is much to be regretted that in a country so renowned as this is for its wealth and commerce, book-keeping should not be more generally and intelligently studied. Unfortunately a notion prevails

that it is a complex and arbitrary system without any fixed principles or any intelligible rules. Nothing, however, could be more erroneous. Book-keeping is a system of as great perfection and beauty as anything human can be, and it is based upon principles which are simple, unalterable, and capable of universal application.

When its importance and true character shall come to be properly understood, book-keeping will undoubtedly be recognised as a necessary branch of general education; and to be ignorant of the science of accounts will be held to be scandalous, not only in the trader, who should be the guardian of his own interests, but also in directors of companies and guardians of charities, to whom are entrusted the interests of others. There are but few persons who have any adequate conception of the number of bankruptcies which have resulted from irregular accounts alone, or of the extent of the waste, peculation, and frauds which the absence of an intelligent scrutiny of accounts has first encouraged, and afterwards concealed.

It is deserving of notice that of late years the executive government has done much to promote the study of book-keeping in this country. The Lords of Her Majesty's Treasury have made a competent knowledge of the art an indispensable qualification, in candidates for certain branches of the civil service; and the Poor Law Commissioners for England and Wales, in the year 1847, issued an able order prescribing the accounts to be kept in all the Poor Law Unions under their control.

Book-keeping by double entry is alike applicable to the accounts of merchants, manufacturers, traders, public companies and bodies, and private individuals; but for the sake of brevity, we shall confine our remarks to accounts of the first-mentioned class.

The first necessity is that the merchant should secure a record of every fact and transaction affecting his property.

Formerly this record was kept in a book known as the Waste-Book, but experience having shown the inconvenience of a register in which no regard was paid to the classification of the entries (purchases and sales, payments and receipts, being jumbled together), the Waste-Book is now subdivided by every merchant according to the nature of his business. A common division of that book is the following:—

I. The Day-Book, or Invoice-Book Outwards, in which the merchant records his sales *on credit*. Should he sell any of his goods for cash, he must enter those sales separately in a Cash Sales-Book.

II. The Invoice-Book Inwards, in which he records his purchases *on credit*. A common mode of keeping this book is to paste into it the invoices in the order in which they are received.

III. The Cash-Book, on the left-hand side of which he enters all cash received, and on the right-hand side all cash paid. Discount received and allowed is sometimes shown in inner columns of this book.

IV. The Bill-Book, in one part of which he records all the bills *receivable*, and in another part all the bills *payable*.

V. The Stock-Book, or Inventory, in which he enters an account of his stock on hand at the time of the balancing of his books.

All the books of this class are perfectly simple in their character, and when properly kept contain all the necessary data for the correct statement of the accounts in the Ledger—a book of which we shall speak presently—hence they are called *subsidiary books*.

Too much care cannot be bestowed on the selection and preparation of the subsidiary books, so as to adapt them to the particular business in which the merchant is engaged. The subsidiary books of a trader will differ from those of a merchant, and these again will differ from the subsidiary books of a broker. The object, however, of the subsidiary books is in all cases the same, namely, to obtain a classified record of every fact affecting the property of the individual.

Now, double entry addresses itself to the collection into a book called the Ledger, of all the facts scattered through the subsidiary books, and to the arrangement of those facts in that book with such accuracy and conciseness as to show at a glance the precise state of the merchant's affairs. The supreme importance of this book—in which the accounts take their ultimate and scientific character—will be readily perceived.

The accounts in the Ledger are divided into

I. Personal accounts.
II. Real accounts.
III. Fictitious accounts.

I. The Personal accounts are those opened with the persons with whom the merchant has dealings *on credit*. These accounts show him whether those persons owe him anything, and if so how much, or whether he owes them anything, and if so how much.—See Ledger accounts, 9, 10, 11, and 12.

II. The Real accounts are the accounts of his property, and show how, where, and in what proportions it is invested. It is in the nature of a merchant's transactions that his property should be in a state of constant change. His cash of to-day may be merchandise to-morrow, and the bills receivable of to-morrow may be cash on the third day. The Real accounts show these changes in his property.—See Ledger accounts, 2, 3, 4, 5, 7, and 8.

III. The Fictitious accounts are those showing his gains and losses; but why these accounts should be called fictitious it would puzzle any one—and we therefore will not attempt—to say.—See Ledger accounts, 1, 13, 14, and 15.

Double entry takes its stand upon the scientific axiom, that "the whole is equal to the sum of all its parts;" or, conversely, that "all the parts taken together are equal to the whole." An examination of the following Stock account will show that that account exhibits "the whole" of the merchant's property, taken collectively; and an examination of the remaining accounts will show that they exhibit "all the parts" of his property taken separately. It follows therefore that all the *parts* as represented by such remaining accounts must in all cases be equal to the *whole*, as represented by the Stock account. This is the distinguishing feature of double entry; it records all its facts, and arrives at all its conclusions by a *double process*, the one process operating as a check upon the other.

This brings us to the fundamental principle of double entry, which is that every fact carried to the Ledger must be entered *twice*, that is, on the Dr., or lefthand side of one account, and on the Cr., or righthand side of another account. *The account giving out the item is always the Cr., and the account receiving it is always the Dr.* By this means the aggregate amount of all the debtors in the Ledger is at all times equal to the aggregate amount of all the creditors. The accounts are thus kept in a state of constant equilibrium. An illustration of this truth is given in the *Journal*.

It is the practice of book-keepers, before closing their accounts at any given period, to ascertain by adding up both sides of their Ledger, whether an equilibrium of debtors and creditors has been duly preserved, and this is called making a *trial* balance. If an equilibrium has not been preserved at every stage of the posting of that book, the accounts cannot be correct.

We will now give a concise exemplification of the foregoing principles.

For this purpose let us suppose that we want to know the state of a merchant's affairs on a given day, say the 31st of January. We turn to his subsidiary books and find that when his position was last ascertained (say on the 1st of January), it was as follows:—

ASSETS.

	£
Cash	500
Wine (50 pipes, valued at 70*l.* per pipe)	3,500
Merchandise (exclusive of wine) valued at	10,000
Bills receivable	100
M. Moythan owes	100
Sugar in Co. valued at	300
	£14,500

LIABILITIES.

	£
Bills payable	150
J. Jenks, due to him	50
	£200

By his Day-Book we find that he has since sold 500*l.* worth of goods and 2000*l.* worth of wine to M. Moythan, and 1500*l.* worth of goods to J. Jenks; and that he has sent 200*l.* worth of goods to Hull on speculation, the charges on which amounted to 10*l.*

By his Invoice-Book we find that he has purchased 200*l.* worth of goods from R. Lloyd, and 400*l.* worth from T. Nott.

By his Cash-Book we find that he has *received* 2600*l.* from M. Moythan; 1200*l.* from J. Jenks; 190*l.* from his adventure to Hull; 50*l.* in payment of one of his bills receivable; and 350*l.* for the sugar in company; and that he has *paid* 100*l.* in discharge of one of his bills payable, and 80*l.* for rent and wages. On turning to his Bill-Book we do not find that he has either issued or received any bill during the month.

To facilitate the posting of the Ledger from the subsidiary books, an intermediate book is used called the Journal, the object of which is to indicate to what accounts, and to which side of each account, the transactions recorded in the subsidiary books are to be carried. In the infancy of the art it was customary to post and journalise each transaction separately, but experience having shown the inconvenience of that practice, it has long been discontinued. The practice which now obtains is to journalise the transactions *monthly* instead of daily and to include in one entry all the transactions of the month belonging to the same class. Thus, instead of journalising each item appearing on the Dr. side of the Cash-Book separately, all the cash receipts of the month are entered together as *Cash Dr. to Sundries*, the word Sundries always meaning in book-keeping not sundry or several articles but sundry or several accounts. By this contrivance there never can be more entries in the Ledger account than *twelve* on each side, namely *one* for each month in the year.

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Drs. £	s.	d.		Crs. £	s.	d.
			Sundries Dr. to Stock	14,500	0	0
500	0	0	Cash.			
3,500	0	0	Wine.			
10,000	0	0	Merchandise.			
100	0	0	Bills Receivable.			
100	0	0	M. Moythan.			
300	0	0	Sugar in Co.			
			. . . . . Stock Dr. to Sundries.			
200	0	0	Bills Payable	150	0	0
			J. Jenks	50	0	0
			(This is the Journal entry of the Merchant's position at the opening of the books.)			
			Sundries Dr. to Merchandise	2,000	0	0
500	0	0	M. Moythan.			
1,500	0	0	J. Jenks.			
			. . . . M. Moythan Dr. to Wine			
2,000	0	0	25 Pipes	2,000	0	0
			. . . . Adventure to Hull Dr. to Sundries.			
210	0	0	Merchandise	200	0	0
			Charges	10	0	0
			(This is the Journal entry of the transactions recorded in the Day-Book.)			
			. . . . . Merchandise Dr. to Sundries			
600	0	0	R. Lloyd	200	0	0
			T. Nott	400	0	0
			(This is the Journal entry of the month's purchases.)			
			. . . . . Cash Dr. to Sundries.			
4,390	0	0	M. Moythan	2,600	0	0
			J. Jenks	1,200	0	0
			Adventure to Hull	190	0	0
			Bills Receivable	50	0	0
			Sugar in Co.	350	0	0
			Sundries Dr. to Cash	180	0	0
100	0	0	Bills Payable.			
80	0	0	Charges.			
			(This is the Journal entry of the month's cash transactions.)			
£24,080	0	0	Equilibrium	£24,080	0	0

THE LEDGER ACCOUNTS.

1.

Dr. STOCK. Cr.

		£	s.	d.			£	s.	d.
January 1	To Sundries	200	0	0	January 1	By Sundries	14,500	0	0
„ 31	To BALANCE *for present worth* . .	14,887	0	0	„ 31	*By Profit and Loss*	587	0	0
		£15,087	0	0			£15,087	0	0

On the opening of the books this account is *credited* with the total amount of the merchant's property, and *debited* with the total amount of his liabilities; the *difference* being his net worth. No further entry is made in this account until the Ledger has to be balanced.

2.

Dr. CASH. Cr.

		£	s.	d.			£	s.	d.
January 1	To Stock	500	0	0	January 31	By Sundries	180	0	0
„ 31	To Sundries	4,390	0	0	„	*By Balance*	4,710	0	0
		£4,890	0	0			£4,890	0	0

At the commencement of the year, Stock *gave out* 14,500*l.* to the several branches of the business. Stock therefore was *credited* with that amount, and Cash, Bills, &c., *debited* with the proportions of that sum which they respectively *received*. This account is *debited* with all cash coming in and *credited* with all cash going out, the difference being the amount of the cash in hand.

3.

Dr.		WINE.						Cr.
		Pi.	£	s.	d.			Pi.	£	s.	d.
January 1	To Stock	50	3,500	0	0	January 31	By M. Moythan . . .	25	2,000	0	0
„ 31	*To Profit and Loss for Gain* .		250	0	0	„ „	*By Balance on hand* . . .	25	1,750	0	0
		50	£3,750	0	0			50	£3,750	0	0

An account must be opened for every species of property the gain or loss on which is to be computed separately. If therefore the merchant wishes to know exactly the result of his dealings in wine, he must open an account for it as above, distinct from his other merchandise. The Dr. side shows the outlay upon the wine *coming in*, and the Cr. side the returns for the wine *going out*. To ascertain the gain or loss, the value of the wine unsold must be entered on the Cr. side, the difference between the two sides of the account will then be the merchant's gain or loss. In this case it is gain, and must be entered on the Dr. side, and be from there carried to the Profit and Loss account.

4.

Dr.		MERCHANDISE.						Cr.
		£	s.	d.			£	s.	d.
January 1	To Stock	10,000	0	0	January 31	By Sundries	2,000	0	0
„ „	To Sundries	600	0	0	„ „	By Adventure to Hull	200	0	0
„ „	*To Profit and Loss for Gain* . .	400	0	0	„ „	*By Balance on hand*	8,800	0	0
		£11,000	0	0			£11,000	0	0

In those trades in which goods are sold in small quantities, it is impossible to keep an account of every article in the Ledger, and in those cases in which it is possible, it is generally very undesirable to do so. It is therefore usual for one general account of merchandise to be kept, as above. This account shows the gain or loss on the merchandise as a whole. It is *debited* with the outlay on the goods *coming in*, and *credited* with the sales, or returns on the goods *going out*, in the same manner as the Wine account. To close this account, the value of the merchandise on hand is ascertained, by "taking stock," and entered on the Cr. side. The difference between the two sides is then the gain or loss. In this case it is gain; it must therefore be entered on the Dr. side, and from there be carried to the Profit and Loss account.

5.

Dr.		BILLS RECEIVABLE.						Cr.
		£	s.	d.			£	s.	d.
January 1	To Stock	100	0	0	January 31	By Cash	50	0	0
					„ „	*By Balance*	50	0	0
		£100	0	0			£100	0	0

The Dr. side of this account shows the amount of the bills which were owing (or receivable) on the 1st of January. No bills have come into the merchant's hands since that time, or they too would appear on this side. The Cr. side shows the amount of the bills disposed of. The balance is the amount of the bills now owing *to* the merchant.

6.

Dr.		BILLS PAYABLE.						Cr.
		£	s.	d.			£	s.	d.
January 31	To Cash	100	0	0	January 1	By Stock	150	0	0
„ „	*To Balance*	50	0	0					
		£150	0	0			£150	0	0

This account is *credited* with all bills issued or accepted by the merchant, and *debited* with all bills paid off or redeemed by him. The difference between the two sides of the account is the amount of the bills owing *by* the merchant.

7.

Dr.		SUGAR IN CO.						Cr.
		£	s.	d.			£	s.	d.
January 1	To Stock	300	0	0	January 31	By Cash	350	0	0
„ 31	*To Profit and Loss for Commission* .	4	0	0					
„ „	*To Profit and Loss for ½ Net Gain* .	23	0	0					
„ „	*To J. Jenks for ½ Net Gain* . . .	23	0	0					
		£350	0	0			£350	0	0

Prior to the 1st of January, the merchant and J. Jenks had purchased some sugar between them, on the understanding that they should share the profits equally. This is the account of that joint speculation, the words "in Co." indicating the partnership. It is *debited* with the outlay, and also with the commission charged by the merchant for managing the speculation, and *credited* with the returns. The difference between the two sides of the account (the sugar being all sold) is the profit, one-half of which has to be carried to the credit of J. Jenks, and the other half to the merchant's credit, in his Profit and Loss account.

8.

Dr.	ADVENTURE TO HULL.				Cr.			
		£	s.	d.			£	s.	d.
January 31	To Merchandise	200	0	0	January 31	By Cash	190	0	0
„ „	To Charges	10	0	0	„ „	*By Profit and Loss for Loss*	20	0	0
		£210	0	0			£210	0	0

This is the account of the goods which the merchant sent to Hull. It is *debited* with the value of the goods, and with the expenses attending the adventure, and *credited* with the returns. In this case, the returns fell short of the outlay; the difference is therefore loss, which must be entered on the Cr. side of this account, and from there carried to the Dr. side of Profit and Loss.

9.

Dr.	M. MOYTHAN.				Cr.			
		£	s.	d.			£	s.	d.
January 1	To Stock	100	0	0	January 31	By Cash	2,600	0	0
„ 31	To Merchandise	500	0	0					
„ „	To Wine	2,000	0	0					
		£2,600	0	0			£2,600	0	0

This and the three following are Personal accounts. In each case the person is *debited* with what he receives, and *credited* with what the merchant receives from him. In this case the two sides of the account are equal, the account is therefore clear.

10.

Dr.	J. JENKS.				Cr.			
		£	s.	d.			£	s.	d.
January 31	To Merchandise	1,500	0	0	January 1	By Stock	50	0	0
					„ 31	By Cash	1,200	0	0
					„ „	By Sugar in Co. for ½ Profits	23	0	0
					„ „	*By Balance*	227	0	0
		£1,500	0	0			£1,500	0	0

In this case the Dr. side is the greater, therefore J. Jenks owes money to the merchant.

11.

Dr.	R. LLOYD.				Cr.			
		£	s.	d.			£	s.	d.
January 31	*To Balance*	200	0	0	January 31	By Merchandise	200	0	0

In this case the Cr. side is the greater, therefore the merchant owes money to R. Lloyd.

12.

Dr.	T. NOTT.				Cr.			
		£	s.	d.			£	s.	d.
January 31	*To Balance*	400	0	0	January 31	By Merchandise	400	0	0

This account is precisely similar to the preceding account.

13.

Dr.	CHARGES.				Cr.			
		£	s.	d.			£	s.	d.
January 31	To Cash	80	0	0	January 31	By Adventure to Hull	10	0	0
					„ „	*By Profit and Loss for Loss*	70	0	0
		£80	0	0			£80	0	0

All expenditure in respect of which no returns are received, such as rent, wages, interest of money borrowed, &c., may be placed *direct* to the *debit* of Profit and Loss; and all receipts in respect of which no property is exchanged, such as commission and discounts, may be placed *direct* to the *credit* of Profit and Loss, *or* separate accounts of them may be opened, and only the balance transferred to that account when the books are to be balanced. In this exemplification we have taken the first course with respect to *Commission*, and the second course as regards *Rent* and *Wages*.

14.

DR. PROFIT AND LOSS. CR.

	Losses.	£	*s.*	*d.*		*Gains.*	£	*s.*	*d.*
January 31	To Adventure to Hull	20	0	0	January 31	By Wine	250	0	0
,,	To Charges	70	0	0	,,	By Merchandise	400	0	0
,,	*To* STOCK *for net gain*	587	0	0	,,	By Sugar in Co.	27	0	0
		£677	0	0			£677	0	0

This is the account in which all the merchant's gains and losses are collected together, the losses on the Dr. side, and the gains on the Cr. side. The Gains less the Losses give the merchant's net gains, which must be carried to his Stock or Capital account.

15.

DR. BALANCE. CR.

	Assets.	£	*s.*	*d.*		*Liabilities.*	£	*s.*	*d.*
January 31	To Cash	4,710	0	0	January 31	By Bills Payable	50	0	0
,,	To Wine	1,750	0	0	,,	By R. Lloyd	200	0	0
,,	To Merchandise	8,800	0	0	,,	By T. Nott	400	0	0
,,	To Bills Receivable	50	0	0	,,	*By* STOCK *for present worth*	14,887	0	0
,,	To J. Jenks	227	0	0					
		£15,537	0	0			£15,537	0	0

The Balance-Sheet is drawn out when the merchant wishes to ascertain the state of his affairs, and is a collected statement of his assets and liabilities. His assets are found in the balances appearing on the **Cr.** side of the Ledger accounts, and these are all brought to the Dr. of the Balance-Sheet. His liabilities are found in the balances appearing on the **Dr.** side of his Ledger accounts, and these are all brought to the Cr. side of the Balance-Sheet. The difference between his assets and his liabilities is his present worth, which must be entered on the Cr. side of the Balance-Sheet, and from there carried to the Dr. side of the Stock account. The Profit and Loss account and the Balance account are closed by the Stock account.

The reader will now observe, on reference to the latter account, that we have arrived at the merchant's present worth by two distinct processes: 1st. By adding his net gains to his original net capital; and, 2nd. By deducting his liabilities from his assets: and that the result by each process is the same. He will further observe that the two sides of the Stock account are now equal, in which fact we find satisfactory evidence that the accounts are correct.

Partnership accounts are kept in precisely the same manner as the accounts of a single trader. But in partnerships the Stock account represents THE CONCERN, and Personal accounts have to be opened with each of the partners. These personal accounts are credited with what the partners respectively bring into the concern, and debited with whatever they draw out. At the balancing of the books the profits are divided, and the share of each partner is brought to the credit of his account.

Book-Keeping by Single Entry.—In book-keeping by single entry, the transactions recorded in the subsidiary books are entered *once* to some account in the Ledger, instead of *twice*, as in double entry. Single entry is employed by many retail traders, but it is an unscientific and unsatisfactory system, and wholly inadequate to the statement of complex transactions.

BOOT AND SHOE MANUFACTURE. Scarcely any handicraft employment engages the attention of so many persons in this country as boot and shoe making. From the artist of aristocratic circles, to the cobbler who rolls himself up in a stall under a pot-house, is a wide interval; and this interval is filled up by numerous grades. At Northampton and Stafford, boots and shoes are made on a very large scale for the London market; they include chiefly the cheap varieties; but at some of the recent exhibitions of manufactures the Northampton boot-makers have exhibited specimens of workmanship which are considered to fall in no way behind those of London or Paris. In various country towns the strong coarse 'hob-nailed' shoes are made, which are so much worn by waggoners and others. The London makers import from Paris very large quantities of boot *fronts*, which when combined with other parts of English manufacture, constitute many of the 'French boots' which now glitter in the windows.

The mechanical details of the manufacture have been well described by Mr. Devlin; who, in his 'Shoemaker,' forming one of the 'Guides to Trade,' has contrived to throw a general interest into that which would otherwise be merely technical. The processes of cutting and sewing the leather are, however, not of such a nature as to call for detailed description here.

Many improvements or suggested improvements in boot and shoe making have been patented within the last few years. M. Lefébre, of Paris, has introduced boots and shoes, the soles and heels of which require no stitching. Machinery is employed, whereby the sole and the heel are fastened to the welt by brass screws; the closeness of contact being equal (as is said) to a pressure of two or three cwt. Some of our readers may remember that one of these boot-screwing machines was displayed at the Great Exhibition of 1851. Mr. Waite, a London manufacturer, patented a few years ago a series of machines to supersede the necessity for clickers, in cutting out women's and children's boots and shoes. The advantages of the apparatus are said by the inventor to be, that six hundred dozens of boot-linings can be properly prepared for the binders in twelve hours; and that the skins used in the manufacture can be prepared for the binders in one-tenth part of the time usually required, and at a less expense. The same manufacturer has also invented a machine for modelling instep-pieces for women's and children's boots and shoes. Another recent machine is Mansell's blocking apparatus, to effect the blocking of a boot in much less than the usual time, and with less injury to the leather. A piece of leather, cut to the proper shape for the front of a boot, is well soaked in water; a small quantity of 'dubbing' (a kind of oily paste-blacking) is spread on that part of the front which corresponds to the instep; and the leather so prepared is laid on the upper surface of two iron cheeks. A winch is then turned; and, with the assistance of cog-wheels, the leather is brought down between the cheeks by a plate of zinc, and descends below the cheeks. This operation is repeated according to the strength of the leather. Another invention, by Mr. Marsden, relates to ventilating openings at the sides, kept open by small metallic plates. Among the other novelties are Durenville's system of machinery for cutting and making boots and shoes; Hetley's plan for producing shoe-leather by a curious combination of leather raspings with india-rubber and gutta percha, pressed into blocks, and sliced; a plan for sewing together the different parts of a boot or shoe with wire thread instead of hempen thread; and a curious adaptation of revolving circular heels, which may be turned round in order that every part may receive equal wear.

The principal recent novelties in boot and shoe making, however, result from the use of india-rubber or gutta percha. Gutta percha, applied for under-leathers, is found serviceable in withstanding moisture; though it is not adapted for hot and dry climates. The American over-shoes, made entirely of vulcanised india-rubber, will withstand both moisture and heat, and are much worn as clogs or temporary coverings for other boots or shoes in inclement weather. In other instances, india-rubber is applied to give elasticity to certain parts of a boot; and the so-called 'resilient,' and 'siccopedean,' and 'tei-ideio-elasticon' boots and shoes, are simply applications of this elastic substance where it may be most useful. As a proof of what may be effected by the use of this material, a pair of boots for a jockey has been made weighing only three ounces. One inventor has devised a mode of introducing a layer of gutta percha between the outer and inner soles; and another has proposed the use of heels made of an iron rim, with the vacuity filled up with gutta percha.

Boots and shoes for the army deserve more attention than they have received. The late Sir M. I. Brunel invented a most ingenious system of machinery for manufacturing soldiers' shoes with great rapidity; but the plan, through some deficiency in its results, was never very extensively adopted. Mr. Dowie at the present time makes soldiers' shoes, with a peculiar elastic piece between the sole and heel, to enable the shoe to accommodate itself to the bending of the foot in walking.

During the Crimean war, the sufferings of the troops were greatly and unnecessarily increased by the shameful quality of the boots and shoes supplied to the army by some of the contractors. Mr. Medwin, an experienced boot-maker, in a letter to the 'Times,' detailed in the following terms some of the causes of this unsuitableness. Referring to water-boots for wet weather, he said: "The straps used for these have been a piece of narrow cotton tape, breaking after two or three times of trial, and causing the boots, especially if damp, to pull on with much difficulty. A leather strap substituted for the cotton tape would cost no more, and would last out the boot. The inner sole, or that on which the foot rests, being a part not seen, is generally in an untanned, or nearly in its raw green state; the effect of this is inevitably to blister and draw the feet; and when this crude leather is drying, after the boot has been damp or in water, materially to shrink and contract it. Through carelessness or want of judgment the seams in the shorter boots are so placed as if purposely to cut like a tightened cord over the most tender parts of the foot: and this where there is most exposure to the weather, and where also the work is most likely to come undone, and to be difficult of repair. If the boot were properly contrived, no seam would be needed across this susceptible portion of the foot; all pressure would be thus got rid of, and one fruitful cause for the necessity of repairs removed. I venture to affirm that, so far as the structure of the foot is concerned, our army boots are fully a century behind the improvements of the day—loose, where a hold upon the foot is needed; and consequently tight across the articulated portions of the foot, where ease, play, and freedom are especially required." He affirmed that well-made and well-fitting boots and shoes might be supplied to the army at prices not exceeding those now paid by the nation for ill-made articles. An inquiry made in 1858, by a body of special commissioners, into certain defalcations at the military depôt at Weedon, brought to light many facts tending to show in what manner official mismanagement led to a great waste of public money in obtaining supplies of soldiers' boots and shoes.

The boot and shoe manufacture has till now (1859) been almost wholly a handicraft employment; but the manufacturers of Northampton and Stafford are gradually introducing sewing-machines, to expedite certain departments of the labour. The workmen are bringing all the force of combination and trades' unions to resist this innovation; but the past history of manufactures points clearly to the impossibility of preventing the introduction of such machinery as will expedite the processes or diminish the cost of labour.

Notwithstanding the large number of persons employed in this trade in England, and the abundant supply of leather, there is still a considerable importation of boots and shoes from abroad, chiefly French. These importations, however, are much more largely in boot-fronts than in finished boots and shoes; owing to a considerable difference in the rate of duty. The boots, shoes, goloshes, and boot-fronts imported in the last three years amounted to the following quantities:—

	Boots, Shoes, and Goloshes.	Boot Fronts.	Total.
	Pairs.	Pairs.	Pairs.
1856 . .	189,835	670,510	860,345
1857 . . .	194,991	551,171	750,162
1858 . .	165,466	609,596	775,062

BOO'TES (from the Greek Boῦs, *bos*, "an ox"), one of the old constellations. Its name signifies the *herdsman;* but it is as frequently called *Arctophylax* by the ancients, which means the *guard of the bear*. Aratus calls it by both names.

"Arctophylax, vulgo qui dicitur esse Boötes,"

is the version of Cicero. Both Aratus and Hyginus place ARCTURUS in or under the girdle; but it is usual to draw it between the legs of the figure. Manilius also uses both names. The constellation is connected mythologically with the fables of Arcas, Icarus, Lycaon, and others. The Arabic translators of Ptolemy rendered Boötes by *bellower* or *vociferator*. According to the old figures attached to Hyginus, he is represented as a man with a spear in the right hand (viewed from the back—BAYER, in BIOG. DIV.) and a sickle in the left. The modern figures represent a man with a club in the right hand (viewed in front), and in the left the string which holds the two dogs (Cases Venatici). It would seem to be probable that the Great Bear was originally either an agricultural animal or instrument (an ox, an ass, or a waggon), and Boötes the driver.

The principal stars in Boötes are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
τ	4	4597	4
υ	5	4615	4
η	8	4648	3
α	16	4729	1
κ	17	4726	4
λ	19	4741	4
ι	21	4742	4
θ	23	4789	4
ρ	25	4808	4

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
γ	27	4812	3½
π	29	4847	3
ζ	30	4849	3½
ϵ	36	4876	3
ξ	37	4905	3½
β	42	4958	3
δ	49	5036	3½

BORACIC ACID (BO_3), formerly called *Homberg's sedative salt* and *sedative salt of borax*, is a compound of the elementary body *boron* and oxygen. It exists in considerable quantity in combination with soda in the waters of certain lakes in Thibet and Persia, forming borax or the biborate of soda. From this salt, which is mentioned under the head of salts of boracic acid, termed *borates*, it is procured by dissolving four parts of it in sixteen parts of boiling water, and adding one part of concentrated sulphuric acid to the filtered solution. Owing to the superior affinity of the sulphuric acid for the soda, sulphate of soda is formed, and the boracic acid separated crystallises as the solution cools: it is to be allowed to drain, to be redissolved in boiling water, and again crystallised to separate the sulphuric acid which adheres to it. In order to purify it entirely from this acid, Berzelius recommends that it should be fused in a platinum crucible, and again dissolved in boiling water and crystallised.

Boracic acid in the uncombined state is found in the hot aqueous and sulphurous vapours that issue from the earth in the volcanic district of Tuscany. It is obtained in the following manner: Round the larger fissures in the sides of a hill basins are dug, usually about five feet deep and fifteen feet in diameter. Into these, called *lagoni* (lagoons), water from a small stream is conducted, and the hot vapours passing through them, leave behind the boracic acid in solution. The hot liquid is then run off into lagoons on a lower level, and finally, after standing some time in reservoirs to deposit suspended impurities, is concentrated in shallow leaden vessels ingeniously heated by flues, through which the hot vapours issuing from some of the fissures are made to pass. On the cooling of the concentrated solution, the boracic acid crystallises out, and when dried, is packed in casks and sent into commerce. It always requires subsequent purification by re-crystallisation.

Boracic acid has the form of small scaly brilliant colourless crystals, which have a greasy feel. This acid is inodorous; its taste is not strong, and scarcely at all acid. It reddens litmus paper but slightly, and turns turmeric paper brown, as the alkalies do. Water at 60° dissolves about 1-26th of its weight of this acid, and boiling water nearly one-third. It contains about forty-four per cent. of water of crystallisation, which is entirely expelled when it is gradually heated to redness in a platinum crucible. If the crystals are suddenly heated, a portion of the acid is carried off by the vapour of the expelled water. When fused boracic acid cools and becomes solid, it splits, and during this operation it is luminous in the dark; the light is probably electric.

When a substance is suspected to contain boracic acid, it should be heated with concentrated sulphuric acid, a small quantity of alcohol added, and the mixture inflamed, when the spirit will burn with a green flame if boracic acid is present. Before applying this test, the absence of copper must be ascertained, as it communicates to flame a similar colouration.

Boracic acid in crystals has a specific gravity of 1·48; when fused it is 1·83. It is soluble in alcohol, and the solution burns with a green flame. Although it acts weakly as an acid upon litmus paper, it decomposes the alkaline carbonates with effervescence, and at a red heat it expels most of the volatile acids from their bases.

Boracic acid is, according to Berzelius, composed of

3 equivalents oxygen	24·00
1 do. boron	10·91
Equivalent	34·91

Boracic acid is sometimes used in chemical investigations, and was formerly employed in medicine.

Borates are the salts which contain boracic acid: of these the only important one is

Borax, a compound of boracic acid and soda, the correct appellation of which is biborate of soda. This salt is imported from the East Indies under the name of *tincal* or *rough borax*. It is supposed to be the substance called by Pliny *chrysocolla*. Geber in the 7th century mentions borax; its nature was pointed out by Geoffroy in 1732 and Baron in 1748. It is brought from Persia, Ceylon, and also from Thibet, from a lake entirely supplied by springs, fifteen days' journey from Teeshoo Lumboo the capital. Tincal as imported is mixed with a fatty matter, which may be separated by acids.

The crystals of tincal are bluish or greenish white, and are sometimes nearly transparent, but more commonly opaque. They are soft and brittle. The primary form is an oblique rhombic prism. Tincal is purified by solution in water and crystallisation, and is then sold as borax.

The greater part of commercial borax is now prepared, both in England and France, by saturating with carbonate of soda the boracic acid imported from Tuscany. This salt is little employed in medicine, but is used extensively in the arts as an ingredient in the glaze of the finer kinds of earthenware, and in chemical investigations as a flux.

The primary form of common borax is an oblique rhombic prism, variously modified; but it has been found by Mr. Payen, that if a saturated solution of borax at 174° be slowly cooled, it deposits crystals when the temperature is above 103°, which are in the form of the regular octohedron. These crystals contain only half as much water as those just described.

Borax has rather an alkaline and sweetish taste, acts like alkalies upon turmeric paper, and is soluble in twelve parts of cold and two of boiling water. It effloresces slowly by exposure to the air, and when two pieces are rubbed together in the dark they become luminous. When moderately heated, borax swells and loses about four-tenths of its weight, and assumes the form of a light porous friable mass, and is called *calcined borax*. When very strongly heated, it melts into a transparent glass. According to Berzelius, it is composed of,

2	equivalents	boracic acid . . .	69·80
1	do.	soda	31·32
10	do.	water	90·00
			191·12

BORAX. [Boracic Acid.]

BORDA'RII, one of the classes of agricultural occupiers of land mentioned in the Domesday Survey, and, with the exception of the villani, the largest. The origin of their name, and the exact nature of their tenure, have been variously interpreted. Lord Coke ('Inst.' lib. i. § i. fol. 5 b. edit. 1628) calls them "boors holding a little house, with some land of husbandry, bigger than a cottage." Nichols, in his 'Introduction to the History of Leicestershire,' p. xlv., considers them as cottagers, taking their name from living on the borders of a village or manor: but this is sufficiently refuted by Domesday itself, where we find them not only mentioned generally among the agricultural occupiers of land, but in one instance as "circa aulam manentes," dwelling near the manor-house; and even residing in some of the larger towns. In two quarters of the town of Huntingdon, at the time of forming the Survey, as well as in King Edward the Confessor's time, there were 116 burgesses, and subordinate to them 100 bordarii, who aided them in the payment of the geld or tax. ('Domesd. Book.' tom. i., fol. 203.) In Norwich there were 420 bordarii: and 20 are mentioned as living in Thetford. ('Ibid.' tom. ii., fol. 116 b. 173.)

Bishop Kennett says, "The bordarii often mentioned in the Domesday Inquisition were distinct from the servi and villani, and seem to be those of a less servile condition, who had a bord or cottage with a small parcel of land allowed to them, on condition they should supply the lord with poultry and eggs, and other small provisions for his board and entertainment." ('Gloss. Paroch. Antiq.') Such also is the interpretation given by Blomfield in his 'History of Norfolk.' Brady says, "they were drudges, and performed vile services, which were reserved by the lord upon a poor little house, and a small parcel of land, and might perhaps be domestic works, such as grinding, threshing, drawing water, cutting wood," &c.

Bord, as Bishop Kennett has already noticed, was a cottage. Bordarii, it should seem, were cottagers merely. In one of the Ely Registers we find bordarii, where the breviate of the same entry in Domesday itself reads *cotarii*. Their condition was probably different on different manors. In some entries in the Domesday Survey, "bordarii arantes" occur. At Evesham, on the abbey demesne, 27 bordarii are described as "servientes curiæ." ('Domesd.' tom. i., fol. 175 b.)

On the demesne appertaining to the castle of Ewias, there were 12 bordarii, who are described as performing personal labour on one day in every week. ('Ibid.' fol. 186.) At St. Edmondsbury in Suffolk, the abbot had 118 homagers, and under them 52 bordarii. The total number of bordarii noticed in the different counties of England in Domesday Book is 82,634.

(Ellis's *General Introd. to Domesday Book*; Heywood's *Dissert. upon the Ranks of the People under the Anglo-Saxon Governments.*)

BORDER WARRANT is a writ issued by the sheriffs of the Scottish border counties, to apprehend a person domiciled in England who has incurred debt in Scotland, if he should happen to be in the sheriffs' jurisdiction. It is given on oath being made to the debt, and to the party's domicile. The principle of arrest on mesne process was never sanctioned in Scotland, farther than to the extent of apprehending debtors about to escape from the country (*in meditatione fugæ*) until they should pay their debt or find security for it, and the border warrants, which are in practice disused, are a part of the system.

BORE, less commonly BOAR, a phenomenon which occurs in some rivers, near their mouth at spring tides. When the tide enters the river, the waters suddenly rise to a great height, in some rivers many feet above the surface of the stream, and rush with tremendous noise against the current for a considerable distance. Sometimes the waters do not subside till they have almost reached the limit of tide-water. As this swell does not occur in all rivers where there is a tide, it is evident that it must be caused by some conformation of the banks or bed of the river, or by both combined. It seems to be necessary, in order that there should be a bore, that the river should fall into an estuary, that this estuary be subject to high tides, and that it contract gradually; and lastly that the river also narrows by degrees. The rise of the sea at spring tides pushes a great volume of water into the wide entrance of the estuary, where it accumulates, not being able to flow off quickly enough into the narrower part. The tide therefore enters with the greater force the narrower the estuary becomes, and when it reaches the mouth of the river, the swell has already obtained a considerable height above the descending stream, and rushes on like a torrent.

In England the bore is observed in some rivers, more especially in the Severn, as particularly described below, in which it has a face 9 feet high, the Trent (Stark's 'Gainsborough'), the Wye, in the Solway Frith, and probably in other rivers and estuaries also, in which the water rises suddenly a few feet, and then rushes on against the current of the river. The bore is called in some parts of England, for instance in the Trent and Severn, the Eagre or Hygre. (Gibson's 'Camden,' i. 268; Stark.) This phenomenon takes place near Bordeaux, in the Garonne, and also in its affluent the Dordogne, and is called *le Mascaret*.

Some of the most remarkable bores hitherto described are those of the Ganges and Brahmapootra. In the Hoogly branch of the Ganges the bore is so quick, that it takes only four hours in travelling from Fultah to Nia-serai, above Hoogly town, a distance of nearly 70 miles. At Calcutta it sometimes causes an instantaneous rise of 5 feet, which would occasion great damage among the smaller vessels, if it did not run along one bank only, so that the barges, on hearing the noise which precedes it, can be safely brought to the other side of the river, or to the middle, where the swell is indeed considerable, but not so sudden as to endanger vessels which are skilfully managed. In the channels between the islands at the mouth of the Megna or Brahmapootra, the height of the bore is said to exceed 12 feet, and it is so terrific in its appearances, and so dangerous in its consequences, that no boat will venture to navigate there at spring-tide; but it does not ascend to any great distance in this river, which is probably owing to the great width of the channel of the Megna. Dr. Joseph D. Hooker, F.R.S., in his 'Himalayan Journals' (vol. ii. p. 343), has given a picturesque description of the manner in which his passage, of about 100 miles, from Noacolly on the east bank of the Megna, to Chittagong at its most eastern mouth, was affected by the bore of that river; from which the following particulars are derived: "The great object in this navigation is to keep afloat, and to make progress towards the top of the tide and during its flood, and to ground during the ebb in creeks where the bore (tidal wave) is not violent; for where the channels are broad and open, the height and force of this wave rolls the largest coasting craft over, and swamps them." The ebb, at the mouth of the Fenny, a tributary of the Megna, sometimes retires twenty miles from high-water mark. After this, of course, no water is either to be seen or heard; nothing is visible but glistening oozy mud, except the bleak level surfaces of the islands; until, on the return of the tide, in popular language, a white line is seen on the low black horizon, which is the bore, advancing at the rate of five miles an hour, with a hollow and harsh roar, bearing back the mud that was following the ebb.

It will be seen that there are some unexplained inconsistencies in the several accounts of the bore as occurring in this river, the Ganges, and others, with regard to the comparative safety of vessels in the central streams and near or upon the banks. It is evident, also, that as there is every variety in rivers, with respect to the dimensions of the tidal stream and the rate of contraction of the banks, so there is a corresponding variety in their bores, from the narrow rushing torrent of comparatively great altitude, emphatically the *bore*, to the slightly elevated and accelerated quiet tide-wave. In the case of the Megna, described by Dr. Hooker, we have an intermediate variety.

The bore in the Gulf of Cambay and its tributaries is exceedingly high and rapid, in consequence of which, and of the currents in the gulf, its navigation is dangerous. The phenomenon observed in the mouths of the Indus must be of the same kind. Burnes remarks ('Journal of R. Geog. Soc. Lond.,' vol. iii.) that "the tides rise in the mouths of the Indus about 9 feet at full moon; and flow and ebb with great violence, particularly near the sea, where they flood and abandon the banks with equal and incredible velocity. It is dangerous to drop the anchor unless at low water, as the channel is frequently obscured, and the vessel may be left dry. The tides are only perceptible 75 miles from the sea." The ships of Alexander experienced these dangerous tides in the Indus, and his historian, Arrian, is the first who has described them. ('Anab.' vi. 19.)

The tides in the bay of Fundy are perhaps the highest in the world, the spring tides in some places rising 60 or 70 feet perpendicular; and the bore in the creek of Fundy is higher than in the Severn. On the N. coast of Brazil, especially on the shores of the provinces Parà and Maranhão, a similar phenomenon is observed in some rivers, and in the channel which extends between the coast and a series of islands from Cape Norte to the mouth of the river Macappà. This phenomenon, which is called by the Indians *pororóca*, is particularly strong in the Amazonas, at the junction of the Araguari river, and in the rivers Guama and Capim near Parà, and also in the river Meary in Maranhão The description of the pororóca does not differ materially from that of the bore of the rivers in India, except that it rises to from 12 to 16

feet, and forms three or even four swells, which follow in rapid succession. [AMAZONAS, in GEOG. DIV.] It is also said that some parts of these rivers being obstructed by shoals, the pororóca is only observable on these shoals, and that it disappears in deep water, for which reason the barges are moored in these parts, where they are only exposed to a strong agitation of the waters. (Rennell's 'Hindoostan;' Ayre's 'Corografia Brasilica;' and Eschwege's 'Brasilien.')

The preceding statements comprise the principal facts embraced in the local history of this phenomenon, as described by various observers, and at various periods; but recent investigations, by which the theory of the tides and of waves has been at once corrected and worked out into detail, enable us to add a more explicit view of the nature of the bore, which has become a subject of great theoretical interest.

The Rev. Dr. Whewell has shown that we may consider the banks of a river as a portion of the sea-shore in which there is a point of convergence of tides; and the magnitude of the tides will be increased by this convergence. If we consider the production of these very high tides of convergence as a mechanical question, they may be accounted for by what is called "the principle of the conservation of force." When any quantity of matter is in motion, its motion is capable of carrying every particle of the mass to the height from which it must have fallen to acquire its velocity; but if the motion be employed in raising a smaller quantity of matter, it is capable of raising it to a height proportionally greater. In channels which narrow considerably, the quantity of water raised in the narrow part is less than in the wider, and thus the rise in such cases is greater. The tide being thus made to rise greatly by the contraction of its channel, the part of the water so affected may be abruptly terminated on the inland side, the depth and quantity of water on that side not allowing the surface there to be immediately raised by means of transmitted pressure. A tide-wave thus rendered abrupt, is called a *bore*, and has a close analogy with the waves which curl over and break on a shelving shore. It would appear, indeed, from the researches of Scott Russell, that such waves present us with the limit of the phenomenon. The bore itself, as we have seen, occurs in many places in considerable magnitude, appearing to travel with great rapidity, though moving slower, in fact, than the tide-wave under any other circumstances; and producing great noise by the large amount of intestine motion of its particles.

One of the results of Mr. John Scott Russell's experimental determination of the nature of waves, just cited, is the identification (which had been anticipated by Dr. Whewell) of the tide-wave with that which he has denominated the great primary wave of translation [WAVE], it being the only wave of the ocean belonging to that order. The tide appears to be a compound wave, one elementary wave bringing the first part of flood-tide, another the high water, and so on; these move with different velocities according to the depth. On approaching shallow shores, the anterior tide-waves move more slowly in the shallow water, while the posterior waves moving more rapidly, diminish the distance between successive waves. The tide-wave thus becomes dislocated, its anterior surface rising more rapidly, and its posterior surface descending more slowly than in deep water. According to the principles thus established by Mr. Scott Russell, "a tidal bore is formed when the water is so shallow that the first waves of flood tide move with a velocity so much less than that due to the succeeding part of the tidal-wave, as to be overtaken by the subsequent waves, or wherever the tide rises so rapidly, and the water on the shore or in the river is so shallow, that the height of the first wave of the tide is greater than the depth of the fluid at that place. Hence in deep water vessels are safe from the waves of rivers which injure those on the shore." This last consequence is indicated in the accounts of the local phenomena. (Whewell, 'Essay towards a First Approximation to a Map of Co-tidal Lines.' Phil. Trans., 1833, pp. 203—205; Scott Russell, 'Report on Waves,' Rep. of Seventh Meeting of British Association, 1837, pp. 426, 427.) In some observations made in the Section of Mechanical Science of the same meeting of the Association, Mr. Russell applied his theory of the tide-wave to the improvement of rivers by the removal of the bore, which he stated, "is principally found in rivers and places of rivers where the level of the bed is situated near the level of the mid-tide. This wave changes its form as it approaches a shallow coast, the top being then accelerated, and breaks in a surge when it gets to water of less depth than itself. Supposing, then, that the tide has a bore three feet high, the water being three feet deep, by deepening the channel you remove the bore, and this is the only effectual remedy." ('Athenæum,' 1837, p. 704.)

On reviewing the present state of knowledge and theory on the subject of the bore, as a topical condition of the tidal-wave, it is manifest that science still requires an exact investigation of particular cases, as occurring in localities differently circumstanced, giving precise measures, both of the heights and velocities of the wave, and an application of the theory to explain the varying particulars of the phenomenon; together with an explicit verification of such portions of it as, though in the highest degree probable, must still be regarded as hypothetical.

This is confirmed by the following comprehensive description of the bore by the Astronomer-royal, Mr. Airy, which may be regarded as a commentary both on the local accounts and the theoretical explanations given above. Connected with the rapid rise when the tide is very large in proportion to the depth of the water, "is the bore; a phenomenon on which, we believe," Mr. Airy remarks, "some misconception prevails. We believe that the following description of its cause and appearance will be found correct. It is necessary for its formation that there be a very large tide rising with great rapidity (thus at Newnham [on the Severn], where the water rises 18 feet in an hour and a-half, the bore is considerable). It is necessary, also, that the channel of the river be bordered with a great extent of flat sands near to the level of low water. These circumstances hold in the Severn, the Seine, the Amazonas, the bays at the head of the Bay of Fundy (Chignecto Bay, and the Bay of Mines), and other places where the bore is remarkable: the second does not hold in the Thames; and, in consequence, that river has no bore. When the rise of the tide begins, the surface of the water is disturbed in mid-channel, so as to distort reflection; but the water is not broken, it is merely like a common wave. This point (which we state from our own observation) is fully confirmed by De la Condamine's account of the bore in the Amazonas, and by the practice in the Hoogly river (near Calcutta), and other places subject to a bore, of rowing boats, &c., into the middle of the channel on the approach of the bore, in order to place them out of danger. But as this rapid rise elevates the surface suddenly above the level of the flat sands, the water immediately rushes over them with great velocity, and with a broken front, making a great noise. And this is the whole of the bore. It is, however, a majestic phenomenon, especially when witnessed from a station which commands the river for several miles above and below (we may particularly mention Newnham churchyard, on the Severn), and at an hour when other sounds are stilled. The rise of the water continues, after the bore has passed, with unabated rapidity as far as can be seen by general observation, and the tidal current flows rapidly up the river, which is now quite full. At last its rapidity of rise diminishes, and at 90 minutes after the bore, at the place which we have mentioned, it begins to drop, the current still flowing up. About 15 minutes after the beginning of the drop, a singular line of ripple (of which we can give no further explanation) is seen, stretching across the whole river, and moving very slowly downwards. This appears to be the place at which the ascending current and the descending current meet; for, as soon as it has passed, the water is seen to be running slowly downwards, and in a very short time it is running with a speed which is scarcely to be seen under any other circumstances of any river, except perhaps some of the largest rapids. The remarkable point attending this last phenomenon is, that the phase of change of current moves down the river. In every other instance, the phases, whether of high water, of low water, or of change of current, move upwards; although that of low water moves upwards much more slowly than that of high water. It would seem here that one of the velocities has actually changed its sign." ('Tides and Waves,' 'Ency. Met.,' 514.)

In a paper on the mathematical theory of sound, by the Rev. S. Earnshaw, read before the Royal Society on the 6th of January last (1859), the phenomenon of the bore is investigated in its most simple form, but in harmony with the more complicated cases of the waves of water occurring in nature, and noticed in this article: "It is shown that all the parts of a wave [in this case in a uniform elastic medium] do not travel at the same rate; a circumstance which leads to the formation of a bore in the front of the wave." The principle is then applied to account for several acoustic phenomena, previously unexplained, such as double reports of fire-arms heard at a great distance, and the outrunning of one sound by another, observed by Capt. Parry. ('Proceedings of the Royal Society,' vol. ix. p. 591.) It does not appear that the analogous condition of the undulations of the ether, giving rise to optical phenomena, has been investigated, or even recognised. As the production of the bore results from circumstances foreign and external to the intrinsic nature of waves, it would seem to require for its discovery an artificially constructed system of crystallised bodies, having different refractive and polarising powers for light; though it is not improbable that systems of such a kind as would produce the phenomena may exist in nature.

On the subject of the origin and etymology of *bore* we have no express information. It has been conjectured to be an Indian word, but for this there is no foundation; and a more probable derivation is from the Anglo-Saxon, in the older sense of the English word *to bore*, signifying to penetrate by a powerful forward action. When called the *Boar*, and the *Boar's head*, as is also the case, a comparison with the impetuous rushing career of that animal is suggested, in which the word may have originated. It may be doubted, however, whether most, if not all, the terms designating this phenomenon, are not imitative of the sounds which it produces, and have been involuntarily suggested by them, as occurring in varying intensity and order. The prolonged sound of *bore*, and its French form *barre*, and the Brazilian *pororôca*, are strikingly of this character, which may possibly be attributable to *Hygre* also, given without etymon in our archaic dictionaries; but this is evidently the same word with the Dutch *agger*, denoting the kindred phenomenon of double high-water. Some of these terms may subsequently have been employed in conformity with a supposed etymology, and if such has been the case, as in other cases of the confluence of meaning in philology, further inquiry would be hopeless.

BORING INSTRUMENTS. Whether the vertical cavity for an artesian well is made, or the cavity of a cannon formed, or the cavity

of a cylinder or barrel perfected, or a hole simply made in wood—the term *boring* is equally applied to all these operations.

Cannon are usually cast solid, and bored by machinery; and in an accommodated sense the term is applied to the similar operations by which musket-barrels, the cylinders of steam-engines, and other articles which are originally made hollow, have their inner surface turned to a perfectly smooth surface and cylindrical shape. The boring instruments of the carpenter consist of *awls*, which are put into soft wood, with a rotatory motion, without removing or bringing away its substance; *gimlets* and *augers*, which are supplied with cutting edges, and are partially hollowed, to allow of the escape from the hole of the detached particles of wood; and *bits* of various kinds, which also remove the wood, and are applied with greater power and precision by means of a crank-shaped instrument called a *brace*. Small holes in metals are usually bored with *drills*, which are formed with scraping rather than cutting edges, and are used either in a brace, a drill-stock capable of imparting an alternating rotatory motion by means of a bow worked by hand, or some other contrivance, or in a lathe. Boring machines of the lathe character are too various and complex to be described here. Suffice it to say, that the perfection to which they have been brought, has rendered most essential service to science and manufactures, and removed one of the greatest difficulties experienced by early improvers of the steam-engine.

The boring of Artesian wells is performed with various kinds of chisels or *jumpers*, augers, and instruments suitable for extracting the detached fragments, attached to the lower end of an iron rod formed of many lengths screwed into one another; these instruments are either turned round, or jumped up and down, or worked with a combination of these two motions by suitable mechanism, the kind of tool employed, and the mode of working, being varied from time to time as the several strata are met with.

Beart's boring tools, patented in 1844, are intended to be used in circumstances where the hole made by the borer can be kept constantly full of water. The borer itself is attached to a hollow tube instead of a solid rod, and acts as one leg of a siphon; the other leg being an excavated channel prepared for the purpose, and kept full of water. The arrangement of the several parts is such, that as fast as the fragments of rock or soil are loosened by the borer, they are drawn up with the water by which they become saturated, through the tube which forms the stem or vertical rod of the borer: this, at least, is the theory on which the inventor has founded his patent.

At the meeting of the British Association in 1846, Mr. Vignolles communicated an account of a method of boring Artesian wells, invented by M. Fauvel of Perpignan. M. Fauvel had observed that in several cases of success in boring for water with solid iron rods, so soon as the spring was tapped all the triturated particles were brought up without the use of the auger. He inferred that if the boring could be effected by a hollow tube about two inches less in diameter than the width of the auger, communicating with an injecting force-pump by a flexible tube from the surface, a result would follow similar to that which resulted from the natural power of the rising column of water. Having tested the hypothesis, he found that the well could be bored in much less time than by the former method. The plan has since been largely adopted, in some cases to very great depths.

An attempt was made by Mr. Gard, of Calstock, in 1848, to produce an improved boring-machine, to effect in another way the objects intended by Mr. Beart in England, and M. Fauvel in France. His boring-machine consists of a hollow cylinder, to the bottom of which the boring-bit is attached in a peculiar way; and as the rock or earth is bored, the fragments force themselves up into the cylinder, where they are retained by a valve. The cylinder does not reach to the top of the bore, but requires to be raised when full, in order that it may be emptied; it, however, will contain so large a quantity, that the necessity of raising it will occur much less frequently than under the usual system. Instead of joining successive lengths of rod to the boring tool, the latter is raised and lowered by a chain.

At a meeting of the Cornwall Polytechnic Society, a few years ago, Mr. Prideaux proposed the adoption of a chemical means of facilitating the process of boring. He found that a stream of hydro-oxygen gas applied to a piece of granite stone produced heat; and that on the application of cold water the stone became soft, and yielded to the tool. Oxygen might be superseded by common air from a pair of double bellows; and common coal-gas might be used instead of hydrogen.

A very instructive illustration of the apparatus employed in well-boring may be studied at the Museum of Economic Geology.

BORNEENE. [Camphor.]

BORNEOL. [Camphor.]

BORNEO-CAMPHOR. [Camphor.]

BOROFLUORIC ACID. [Fluoboric Acid.]

BORON (B), an elementary body, and one of the constituents of boracic acid, oxygen being the other. This substance was first obtained by Davy in 1807, and he procured it by exposing slightly moistened boracic acid, placed between two surfaces of platinum, to the action of a Voltaic battery; a dark-coloured substance separated on the negative plate, to which he gave first the name of *boracium*, supposing it would be found to be metallic; but having afterwards ascertained it to be more analogous to carbon than to any other substance, he called it

boron. In this way however little boron was obtained, and its properties were imperfectly examined till 1808, when Gay Lussac and Thenard procured it in larger quantity by heating boracic acid with potassium in a copper tube; by this metal the oxygen was separated from the boron, potash was formed, and boron developed; and the residue of the operation being washed first with water, and then with dilute hydrochloric acid, the boron remains. It is more economically obtained by decomposing an alkaline borofluoride by potassium; for this purpose liquid hydrofluoric acid is to be saturated with boracic acid, and the solution neutralised by carbonate of potash; the salt precipitated is to be well washed with cold water, and dried at nearly a red heat; it is then mixed with an equal weight of potassium, and the mixture heated to redness in a covered iron crucible; the residual mass will be found to consist of boron mixed with fluoride of potassium; the fluoride is dissolved out from the boron by washing with water containing a little chloride of ammonium. The decomposition that takes place is expressed in the following equation:—

$$\underbrace{KF, BF_3}_{\text{Borofluoride of potassium}} + \underbrace{K_3}_{\text{Potassium}} = \underbrace{4KF}_{\text{Fluoride of potassium}} + \underbrace{B}_{\text{Boron}}$$

Boron is a powder of a deep brown colour with a shade of green; and when it has been heated *in vacuo* or in gases which contain no oxygen, it is insoluble in water; and is not dissolved by alcohol, ether, or oils, whether hot or cold. It is devoid of smell and taste. It is not altered by exposure to the air or to oxygen gas at the usual temperatures; but when heated to about 600° it absorbs oxygen, and, burning with considerable brilliancy, is converted into boracic acid; a portion however of the boron is so enveloped by the acid formed, that it is impossible to burn the whole of a given quantity of boron at one operation.

Boron does not decompose water at a boiling temperature. Its density when recently prepared is 1·183, but when it has been exposed to a strong heat in close vessels its density is increased to 1·844, and it suffers no other change, being neither fused nor volatilised. It may be melted however by the heat of a powerful galvanic battery. It is a non-conductor of electricity; the alkalies and acids produce no effect upon it, except the nitric, which it decomposes, and the boron, by acquiring oxygen, is converted into boracic acid. It has a greater affinity for oxygen than carbon, setting the latter element free when it is fused with carbonate of potash.

Prepared by the above method, boron is quite amorphous. According to Professor Wöhler and M. Deville it may be obtained in the crystalline condition by fusing boracic acid with 80 per cent. of the metal aluminium in a powerful furnace. The boracic acid is reduced by a portion of the aluminium, the remainder dissolving the boron, which separates out on cooling in transparent garnet-red crystals of high lustre and refractive power.

Crystallised boron is exceedingly hard. It scratches corundum and even sapphire with ease. A crystal may be crushed with a diamond, but the latter is marked and slightly damaged by the operation. It cannot be fused alone by any known means; it resists the action of oxygen at a far higher temperature than the amorphous variety, even nitrate of potash being without action upon it at a red heat.

Graphitic boron is the name given to that form of the element obtained when borofluoride of potassium is decomposed by aluminium at a high temperature with a flux of the chlorides of potassium and sodium in equivalent proportions. It may be quite freed from aluminium by digesting in hydrochloric acid. It presents a close resemblance to ordinary graphite,—that modification of carbon intermediate between charcoal and diamond. Its appearance is also very similar to graphitic silicon, thus establishing the intimate and interesting physical analogy that exists between these three elements.

Boron combines with various elementary bodies, forming with the metals compounds which are termed *borides*.

Hydrogen and Boron. It appears that, under peculiar circumstances, hydrogen is capable of dissolving a small portion of boron; but no definite compound to which the term boride of hydrogen could be applied is known.

Oxygen and Boron unite, and only in one proportion; the compound is described under Boracic Acid.

Boron and Nitrogen. Boron decomposes nitric oxide at a red heat, boracic acid and nitride of boron (BN) being formed. The latter is a white, light, amorphous powder. Heated with caustic potash, it yields ammonia, borate of the alkali being at the same time produced.

Boron and Sulphur form sulphide of boron (BS_3), but the compound possesses no interest.

Boron and Chlorine unite with considerable energy when the former is heated to redness and plunged into an atmosphere of the latter gas.

Boron and Fluorine combine. [Fluoboric Acid.]

BOROUGH-ENGLISH is a customary descent of lands or tenements, whereby, in all places where this custom holds, lands and tenements descend to the youngest son; or if the owner of land have no issue, then to the youngest brother; as in Edmonton, some parts of Richmond, and other places: and the reason of this custom, says Littleton, is, for that the youngest son is presumed in law to be least able to shift for himself.

Blackstone, who divides the common law into three divisions, treats of Borough-English under the second division, namely :—"Particular customs, which for the most part affect only the inhabitants of particular districts." In the first volume of the 'Commentaries' he gives a definition of the term similar to that contained in Dr. Cowell's Dictionary; and in the second volume he recurs to it, and observes :—"Other authors have indeed given a much stronger reason for this custom, as if the lord of the fee had anciently a right to break the seventh commandment with his tenant's wife on her wedding-night; and that therefore the tenement descended not to the eldest but the youngest son, who was more certainly the offspring of the tenant." Blackstone, however, states that he cannot learn that this right was exercised in England, although it certainly was in Scotland, until abolished by Malcolm III., and in some parts of France; and even if it were, the reason, as it regards the youngest son *only*, is obviously absurd. "Perhaps (he adds) a more rational account than either may be fetched (though at a sufficient distance) from the practice of the Tartars; among whom, according to Father Duhalde, this custom of descent to the youngest son also prevails. That nation is composed totally of shepherds and herdsmen, and the elder sons, as soon as they are capable of leading a pastoral life, migrate from their fathers with a certain allotment of cattle, and go to seek a new habitation. The youngest son, therefore, who continues latest with the father, is naturally the heir of his house, the rest being already provided for. So that possibly this custom, wherever it prevails, may be the remnant of that pastoral state of our British and German ancestors which Cæsar and Tacitus describe." But it is unnecessary to go so far for the origin of a custom which the name itself and other circumstances show to be of English origin.

BOROUGHS, OF GREAT BRITAIN AND IRELAND. [MUNICIPAL CORPORATIONS; COMMONS, HOUSE OF.]

BOSTANJI, from *bostan*, a garden. The class of men who bear this name, who now perform a curious variety of functions, and whose head or chief (Bostanji-Bashi) is one of the grand dignitaries of the Turkish empire, seem originally to have been nothing more than the sultan's gardeners, attached to the imperial residence or seraglio of Constantinople, and were constituted guardians of the seraglio by Soliman the Great. They still work as gardeners in the sultan's pleasure-grounds of Constantinople and on the Bosporus, but the more conspicuous of their duties are, to mount guard in the seraglio, to row the sultan's barge, to row the caïques of all the officers of the palace, to follow those great men, on foot, when they ride on business through the city, and to attend to the execution of the numerous orders of the bostanji-bashi. They were aggregated with the janissaries, with whom they formerly did military duty in the field, but the bostanjis were not suppressed at the sanguinary dissolution of that turbulent militia, although their number has been considerably decreased. When the Ottoman Court was in its splendour, the bostanji corps amounted to 5000 men, who were divided into ortas, or companies, like the janissaries. The distinctive part of their costume was an enormous bonnet, or caouk, made of scarlet cloth, and in war they were increased to 12,000. At present they do not exceed 600.

The bostanji-bashi, who has the rank of a pasha, is governor of the seraglio and the other imperial residences. He is inspector-general of the woods and forests in the neighbourhood of Constantinople. The shores of the Bosporus and the Sea of Marmora, from the mouth of the Black Sea to the Straits of the Dardanelles, are under his jurisdiction, and formerly no person whatsoever could build or even repair a house on those coasts without his permission. For this licence fees were exacted, which were generally fixed in the most arbitrary manner. Whenever the sultan makes an excursion by water (and in the fine seasons he rarely travels in any other way) the bostanji-bashi stands or sits behind him, and steers the magnificent barge, which is rowed by the bostanjis. This brings him into frequent contact and conversation with the sovereign, who never appoints any but personal favourites to the post. At court the bostanji-bashi is almost as great a man as the kislaragha (chief of the black eunuchs) or the selictar (the sultan's sword-bearer). He used also to exercise the functions of provost-master-general, presiding at the bow-stringing of the Turkish grandees when the execution took place within the walls of the seraglio, and superintending the tortures applied in the prison of that palace, to force from obstinate ministers and government functionaries the confession of their guilt and disclosure of their property, which latter was always confiscated to the sultan.

Except when at the helm of the imperial barge, the bostanji-bashi used rarely to be seen abroad by day-light; "no doubt," says D'Ohsson, with much naïveté, "on account of the sensation produced by the presence of the supreme minister of executions."

Another very lucrative duty attached to this composite office was the *inspection* of the trade in wine, and lime, or mortar for building, carried on in the capital and its vicinity. Of late years, however, since Sultan Mahmoud has become a reformer, both the money-getting branches of the office, and the more horrible functions of the bostanji-bashi, have been considerably abridged; and in time we may hope to see him as harmless a character as the commander of a royal yacht or a court chamberlain in Christendom.

BOSWE'LLIA THURI'FERA. A native of the mountainous parts of India; yields the gum-resin (improperly termed gum) olibanum, the

frankincense or *thus* of the ancients. This substance was long supposed to be obtained from various species of *Juniperus* of the family of the *Coniferæ*. Some persons are still of opinion that the Arabian olibanum is derived from a juniperus; which, independent of our positive knowledge of the source of the Indian olibanum, is very improbable, for as Nees von Esenbeck justly remarks, the Coniferæ yield only pure resins, or resins consisting of resin, volatile oil, and sub-resins, but in no case any gum-resins. Indeed, if the Arabian olibanum be not obtained from a Boswellia, it is most probably yielded by a Balsamodendron : (Kafal? Försk. possibly only a variety of *B. Kataf.* Försk.) at least the wood of this tree is used to burn as a perfume in the mosques. There is now scarcely a doubt but that it is the produce of *Boswellia floribunda* of Bennet, the *Plöslea floribunda* of Endlicher. Mr. Johnstone ('Philos. Trans.' for 1839, pp. 304, 305) asserts that there are two distinct gum-resins in olibanum.

The chemical analysis gives very different results, according to the age of the piece examined. Sir William O'Shaughnessy analysed a fine fresh specimen in India, which yielded resin, 37, volatile oil, 28 parts; gum, 4, gluten, 11 per cent. : while Bracoundt, analysing older specimens in Europe, obtained only volatile oil, 8; resin, 56; gum, 30; gum-like matter, loss, &c., 6; showing the gradual conversion of the volatile oil into resin, and the superior quality of fresh specimens.

The odour of olibanum is faint and peculiar, but pleasantly balsamic, which is increased by heat, and when inflamed it burns with a steady, clear light, which is not easily extinguished, diffusing a most fragrant smoke. It leaves behind it a black ash. The taste is balsamic, slightly acrid and bitter. Being a gum-resin, it is not perfectly soluble either in water or alcohol; with the former it forms a milky fluid. It consists of gum-resin and volatile oil : the latter principle has the odour of oil of lemon. The Indian olibanum is not often adulterated, but an inferior or the Arabian kind is often substituted. The latter is frequently intermixed with mastic, gum-sandarac, or Burgundy pitch : when there is much of this last article, it may be discovered by the greater solubility in alcohol.

Olibanum is now seldom used in medicine : it possesses the properties common to balsamic substances, and may, in the absence of inflammatory symptoms, or after appropriate antiphlogistic treatment, be used as an expectorant. It is more useful externally as a rubefacient and antispasmodic, especially applied as a plaster over the stomach in some cases of cramp or spasm of that organ. It is however principally employed to burn as incense in Roman Catholic churches.

BOTTLE PAPERS. A term which of late years has been applied to the inclosures frequently found in bottles discovered floating on the sea, or which have been found cast by the tide upon a shore. It is customary for navigators to endeavour to ascertain the sets of the ocean currents by writing the ship's name, the latitude, longitude, date, &c. on slips of paper, and sealing them securely in wine or other bottles, which when thrown overboard are often drifted into very distant localities, whereby valuable comparisons have already assisted the hydrographer. Some very interesting and important facts connected with bottle papers, and a bottle paper chart may be seen in the 'Nautical Magazine' of September 1857, and in other numbers, as published monthly under the Hydrographic Department of the Admiralty.

BOTTLES, GLASS. The manufacture of these articles is described under GLASS. Considered as a source of revenue, glass-bottles, in common with other descriptions of glass-wares, were first subjected to a duty by the 6 & 7 Will. and Mary; but the duty then imposed, after undergoing various modifications, was repealed four years after by an act, the preamble of which recited that it was "found by experience that the duties on glass and glass-wares are very vexatious and troublesome in the levying and collecting the same, and of small advantage to the Crown, and should the same be continued would lessen the duty on coals much more than the said duties on glass-ware would amount to, would hinder the employing great numbers of poor, and endanger the loss of so beneficial a manufacture to this kingdom." The experience thus recorded led to the exemption of glass-bottles from duty for about half a century; but the exigencies of the State induced the government to reimpose the duty in 1746. The duty, so reimposed, was continued until quite recent times, varied occasionally in ratio.

Glass bottles are now made to such an enormous extent in this country, that after supplying the home demand, a quantity is exported so large as to furnish the following figures :—

	Weight.	Declared Value.
1856 . .	526,813 cwts.	£291,632
1857 . . .	577,209 „	319,480
1858 . .	542,810 „	301,188

These, it must be observed, are designated "common bottles," made of cheap materials, and do not include flint-glass bottles.

BOTTOM HEAT, a term in horticulture expressive of an artificial temperature communicated by means of fermenting matter or otherwise to the soil in which plants grow. It is usually obtained either by leaves, or tan, or fresh stable-litter, thrown into a heap, and enclosed within the walls of a brick pit, the surface of which is covered with soil. The object of the cultivator is by such means to prevent the temperature of the soil from becoming less than 60° Fahr. or more than 90°. The plants to which this kind of temperature is applied

are pine-apples, melons, cucumbers, &c., and certain tropical plants cultivated in stoves.

It is probable that the operation took its rise at a time when it was extremely difficult to procure an equable temperature of the atmosphere by other means; and when, if the heat of smoke in flues was employed, it had the effect of drying the air in which plants were cultivated till it was unfit for their respiration. Fermenting matter, the temperature of which was prolonged and steady, had in addition the great but hardly appreciated convenience, of keeping the air also gently moistened; and in this the greatest advantage was found to result. Physiologists tell us that although the principal part of the water of vegetation is derived from the soil, yet plants are exceedingly benefited by the presence of a certain quantity of vapour in the circumambient air, because it not only prevents a too rapid evaporation from the leaves, but is to a considerable extent absorbed by the young epidermis.

By modern improvements it has been found practicable to maintain the atmosphere of a hothouse in any required state of humidity or temperature; and when steam or hot water are made use of, this may be carried to a great nicety, and the means of doing this are within the reach of most gardeners. One would therefore have thought that the system of bottom-heat would be abandoned. So far however is this from being the case that it is still much employed, and in combination with those additional powers which were originally intended to supersede it.

It is an axiom in horticulture that the more closely we approach nature in our management of plants the more certain are we to succeed in our attempts at cultivation. It therefore becomes an important question whether bottom-heat has any existence in nature; some persons imagine that it can only be looked for in equinoctial climates. But the data that we possess upon this subject, although not very precise, are sufficient to enable us to answer in the affirmative, as has been already stated under the article BARK-BED, to which the reader is referred. Those who hold a different opinion evidently confound cases in which the earth is heated and dried up, with those in which it is merely warmed and maintained in the necessary state of dampness.

BOTTOMRY, BOTTOMREE, or BUMMAREE, is a term derived into the English maritime law from the Dutch or Low German. In Dutch the term is Bomerie or Bodemery, and in German Bodmerei. It is said to be originally derived from Boden or Bodem, which in Low German and Dutch formerly signified the bottom or keel of a ship; and according to a common process in language, the part being applied to the whole, also denoted the ship itself. The same word, differently spelt, has been used in a similar manner in the English language; the expression *bottom* having been commonly used to signify a ship, previously to the 17th century, and being at the present day well known in that sense as a mercantile phrase. Thus it is a familiar mode of expression among merchants to speak of "shipping goods in foreign *bottoms*."

The contract of bottomry in maritime law, is a pledge of the ship as a security for the repayment of money advanced to an owner or master, for the purpose of enabling him to carry on the voyage. It is understood in this contract, which is usually expressed in the form of a bond, called a Bottomry Bond, that if the ship be lost on the voyage, the lender loses the whole of his money; but if the ship and tackle reach the destined port, they become immediately liable for the money lent, and also the premium or interest stipulated to be paid upon the loan. No objection could be made, while the usury laws were in force, on the ground of usury, though the stipulated premium exceeded the legal rate of interest, because the lender was liable to the casualties of the voyage, and was not to receive his money again at all events. In France the contract of bottomry is called *Contrat à la grosse*, and in Italy *Cambio maritimo*, and is subject to different regulations by the respective maritime laws of those countries. The German Bodmerei differs in many of its incidents from Bottomry in this country.

In taking up money upon Bottomry, the loan is made upon the security of the ship alone; but when the advance is made upon the goods and merchandise or lading, then the borrower only is personally liable for the money, and is said to take up money at *respondentia*. In this distinction as to the subject matter of the security, consists the only difference between Bottomry and Respondentia; the rules of English maritime law being equally applicable to both.

The practice of lending money on ships was common in Athens, and in other Greek commercial towns. Money thus lent was sometimes called (*ναυτικὰ χρήματα*) ship-money. Demosthenes (I. *Against Aphobus*), in making a statement of the property left him by his father, enumerates seventy minæ lent on bottomry. If the ship and cargo were lost the lender could not recover his principal or interest; which stipulation was often expressly made in the (*συγγραφή*) bond. (*Demosthenes against Phormion, and against Dionysodorus*, c. 6. 10.) The nature of the bottomry contract is shown in the Oration of Demosthenes against Dionysodorus: 3000 drachmæ were lent on a ship, on condition of her sailing to Egypt and returning to Athens; the money was lent on the double voyage, and the borrower contracted in writing to return direct to Athens, and not dispose of his cargo of Egyptian grain at any other place. He violated his contract by selling his cargo at Rhodes, having been advised by his partner at Athens that the price of grain had fallen in that city since the departure of the vessel. The plaintiff sought to recover principal and interest, of which the borrower attempted to defraud him; damages also were claimed, conformably to the terms of the bond. As neither principal nor interest could be demanded if the vessel were lost, it was a common plea on the part of the borrower that the ship was wrecked.

Money was also lent, under the name of *pecunia trajecticia*, on ships among the Romans, and regulated by various legal provisions. The rate of interest was not limited by law, as in the case of other loans, for the lender ran the risk of losing all if the ship was wrecked; but this extraordinary rate of interest was only due while the vessel was actually at sea.

(Dig. 32, tit. 2. *De Nautico Fœnere;* Molloy, *De Jure Maritimo*, lib ii. c. 11; Arnould, *On Marine Insurance.*)

BOUNTY. 1. A term used in political economy to signify an advantage, chiefly a pecuniary advantage, or premium, allotted and paid by the state, for the export or import of particular articles, or in respect of the production or manufacture of specified commodities, or to persons who employ ships in certain branches of commerce; the object being to encourage and foster the export or import trade of the nation, as embracing those particular articles, to attract industry and capital into the specified branches of production or manufacture, or to engage a larger portion of the shipping interest to turn their attention to the particular lines of commerce designated. In this country the idea of encouraging special modes of enterprise is observable very early in our legislature; but to trace the history of it would, under no circumstances, prove very profitable to the reader, and would be quite impracticable within the limits of this article. Suffice it to say that bounties were held out, by the legislature, in directions so different, and for purposes so various, at different times, that it is most difficult to discover anything in the nature of a governing idea, tending to a defined object, in the vacillating laws that have been passed on this head. Thus in the years 1670 and 1689 respectively, there were enacted bounties on the exportation of corn; in 1795 and 1800 respectively, there was a bounty on the importation of it. The fisheries on various parts of our coasts, especially those of Scotland and Ireland, have perhaps been the fields of industry to which bounties have been most largely and perseveringly applied. The bounty, which had been long continued, under different forms, to the whale fishery, ceased in 1824. The general question of bounties and their impolicy is discussed by Adam Smith in his 'Wealth of Nations,' book iv. chap. 5; and the subject has also been treated in a very complete manner by the late Mr. Ricardo in his 'Principles of Political Economy and Taxation.' When Postlethwaite published his 'Dictionary of Commerce,' in 1774, bounties were "very numerous." After the publication of Adam Smith's work bounties began to be regarded with less favour. They are now no longer relied upon as a means of furthering the true interests of commerce. Adam Smith remarks: "By means of bounties our merchants and manufacturers, it is pretended, will be enabled to sell their goods as cheap or cheaper than their rivals in the foreign markets, . . . We cannot (he adds) force foreigners to buy their goods, as we have done our own countrymen. The next best expedient, it has been thought, therefore, is to *pay* them for *buying*." Bounties in truth effect nothing more than this. The propositions maintained by Adam Smith are, that every trade is in a natural state when goods are sold for a price which replaces the whole capital employed in preparing and sending them to the market, with something in addition in the shape of profit. Such a trade needs no bounties. Individual interest is sufficient to prompt men to engage in carrying it on. On the other hand, when goods are sold at a price which does not replace the cost of the raw material, the wages of labour and all the incidental expenses which have been incurred in bringing them into a state fit for the market, together with the manufacturer's profits; that is, when they are sold at a loss, the manufacturer will cease to produce an unprofitable article, and this particular branch of industry will soon become extinct. It perhaps happens that the general interests of the country are thought to be peculiarly connected with the species of industry in question, and that it therefore behoves government to take means for preventing its falling into decay. At this point commences the operation of bounties, which are devised for the purpose of producing an equilibrium between the cost of production, the market-price, and a remunerating price, the last of which alone promotes the constant activity of every species of industry. Smith observes, "The bounty is given in order to make up this loss, and to encourage a man to continue or perhaps to begin a trade of which the expense is supposed to be greater than the returns; of which every operation eats up a part of the capital employed in it; and which is of such a nature that if all other trades resembled it, there would soon be no capital left in the country." And he adds: "The trades, it is to be observed, which are carried on by means of bounties are the only ones which can be carried on between two nations for any considerable time together, in such a manner as that one of them shall always and regularly lose, or sell its goods for less than they really cost. . . . The effect of bounties, therefore, can only be to force the trade of a country into a channel much less advantageous than that in which it would naturally run of its own accord." One of the most striking instances of the failure of the bounty system occurred about the middle of the last century in connexion with the white herring fishery. Tempted by liberal bounties, persons rashly ventured into the business without a

knowledge of the mode of carrying it on in the most economical and judicious manner, and in no very long space of time a joint-stock of 500,000*l.* was n arly all lost.

There is however a distinction on this subject, which some consider important: it is that which subsists between a bounty given to "enable our merchants and manufacturers to sell their goods as cheap or cheaper than their rivals in the foreign market,"—and a bounty which is given in the hope of raising up in time a manufacture or production, so as to naturalise it, as it were, in the soil which has adaptations for its successful prosecution, but where the taste or turn for taking it up has hitherto been found wanting. This is the species of bounty which, in spite of all the arguments of close reasoners, the statesmen of Europe and other parts of the globe, have, in their several spheres, for many generations, shown a strong determination to adhere to, as a line of useful policy. It is held by some that the policy of bounties has not always been followed by the disastrous results which the abstract doctrines of political economy lead us to anticipate, and they take as an instance to the contrary the case of the beet-root cultivation for the purpose of sugar-making in France. The scheme originated with Napoleon I. in 1811, and was of course "bolstered up" by all kinds of bounties, preferences, and advantages which it was in the power of a despotic government to bestow. At first only from 1½ lb. to 2 lb. of sugar was the produce of 100 lb. of beet-root; in 1836, the system being steadily continued, the produce had risen to 7 lb. and 8lb., and it is said that this sugar, by means of improved chemical appliances and advanced skill, has taken its place in the French markets and competes with colonial sugar. Here, then, it is alleged, is an instance in which a government, looking more to the future than to the present, have, by a policy of encouragement, and no doubt at an immediate loss, and doing violence to scientific rules, at length secured to the country a valuable internal manufacture which affords a large field for the remunerative employment of capital, and yearly absorbs larger quantities of native labour. On the other hand, it may be alleged, that the same amount of capital and labour might have been employed in the commercial exchange of the natural and established products of France for colonial sugar; and that the industry of the country would have been more properly stimulated, and the wants of the consuming population more advantageously supplied, by this exchange of commodities, than by forcing a manufacture which, however it may be partially successful, can never really produce a cheaper commodity than can be had by buying in the cheapest market. The protective system of French commerce, in general, it may be observed, rests upon the same artificial foundation as that of the beet-root manufacture. It is said, also, in favour of bounties, that no one making himself acquainted with the stores of information that have been collected and laid before parliament by various committees, and otherwise, respecting the possible value of the fisheries on the northern coasts and islands of Scotland, and most of the coast of Ireland, can doubt that if by any means the inherent, and it would seem almost indomitable, repugnance to the sea, which characterises the Celtic races, could be overcome, and a sufficient amount of capital and industry could be determined to the vigorous prosecution of those fisheries, incalculable benefits would be conferred on the habitually poverty-stricken and listless populations of those coasts, and a great, and, in many ways most advantageous, trade might be established.

The system of bounties on the exportation of corn was abandoned in this country in 1815; and those on the exportation of linen, and several other articles ceased in 1830. In the same year also ceased the bounties that had been for a long time granted by the legislature for the encouragement and improvement of the British and Irish fisheries, 7 Geo. IV. c. 34; thus putting an end to the payment of any bounties whatever of the class now treated of, and granted by authority of the legislature.

Analogous to and closely connected with this description of bounties is the system of drawback of duties upon the exportation of articles, a system which is still maintained in certain cases. [Drawback.]

2. Bounty, or the Queen's bounty, is a term used to signify a sum of money given by government to persons enlisting in the army or navy, in order to stimulate the supply of men to those services.

The effect of the latter of these bounties appears to be most prejudicial to the interests of commerce. In the spring of 1859 a Royal Proclamation appeared offering a bounty of 10*l.* to able seamen, 5*l.* to ordinary seamen, and 3*l.* to landsmen, who would enlist or enter themselves in the Royal Navy. Before midsummer of the same year, it was stated in Parliament, that since the proclamation the wages of seamen in the mercantile service had been raised 20*s.* a month; that is, the offer of the Government bounty caused an increase in the pay of the 300,000 men who are calculated to be employed in the mercantile marine, of 12*l.* a year per man.

BOUNTY, QUEEN ANNE'S. [Benefice.]

BOW. [Archery.]

BOW, in *Music*, a machine used for drawing out the sounds from—that is, for playing on—stringed instruments of the violin kind. The bow consists of: 1. the stick, which should be of hard elastic wood, Brazil wood being generally used for the purpose; 2. of from eighty to a hundred horsehairs; and 3. of a nut regulated by a screw, by which more or less tension is given to the hairs. The violin bow was very short in Corelli's time, but gradually increased in length, till Viotti, whose *dictum* in whatever concerned his instrument was received as law, fixed it at twenty-eight inches. The violoncello bow is larger and stronger. That for the double-bass is short and strong, and the stick is bent, forming something like the segment of a circle, of which the hairs when stretched are the chord.

BOYAR or BOYARD, the general name for the fief-holders among the Slavonic races, and who ultimately formed the nobility in Russia, Moldavia, and Wallachia. The original nobility of Russia were composed of persons descended from the leading warriors of the first Russian monarch, Rurik and his successors, who, like the Norman warriors under our own William I., received large fiefs in the country which their valour had enabled their chief to win. The fiefs seem to have been held by the sole tenure of military service; they paid no imposts to the prince, but every boyard had in his own possession the same powers and right of customs and tribute which himself had on *his* domains. The fierce struggles between kings and nobles which we read of in other countries were not known in Russia. Various causes have been assigned for this; the veneration generally entertained for the blood of Rurik was doubtless one; to which we may add the circumstances which combined to prevent any great power from being concentrated in the hands of individual nobles. In the first place, the scarcity of cities and strongholds prevented any of the military leaders from perpetuating themselves in their commands; and when the empire was divided into a multitude of small principalities, under the general and indefinite superiority of one Grand Duke, secondary fortunes were subject to continual mutation in the struggles which were always taking place among the princes, and which resulted from the singular law of succession, by which the brother of a deceased prince, and not his son, succeeded to the vacant appanage. It was also an unfavourable circumstance resulting from this law, that the prince of the lateral branch was usually a stranger in the appanage to which he succeeded, and that he generally came to it with a train of nobles and followers who engrossed his favour and preference. In fact, the princes themselves had more analogy than the boyards to the turbulent nobles of France and England; and the boyards themselves resembled the knights, who in those countries regarded the barons as their immediate superiors.

The boyards of Russia, then, owed their final elevation to the extinction of the petty principalities, and to the establishment of the hereditary principle in the succession to the grand dukedom. They had preserved to themselves very extensive privileges and immunities, which were felt to be inconvenient to the power of a despotic monarch. Under Ivan many of these privileges were taken from them, such as their hereditary privilege to certain offices, and their right to transfer their allegiance; but he at the same time bestowed offices on many of them, with a prohibition against leaving the court. This system by degrees reduced them into mere dependents on court favour; and, in fact, the defection of the nobles from their immediate superiors, in order to avail themselves of the more certain protection and larger favours which the Grand Dukes were enabled to offer after the alteration of the order of succession, sealed the ruin of the petty princes, whose contentions had before distracted the empire. From this time we find the boyards occupying trusts which only princes had previously been privileged to hold; and no principle, separately from the general usages of the country, remained to distinguish the Russian nobles from those of other European countries, to which Peter the Great elevated them by his regulations. The distinction, while it existed, operated in giving a very peculiar tone to the early history of the Russian monarchy.

Boyars continue to exist in Moldavia and Wallachia, with many of their original privileges, and much of their original power and influence.

BOYEAU is any trench executed by the besiegers of a fortress to serve as a covered communication, or line of approach, during the progress of the siege. It receives the denomination of a parallel, an oblique, or a zig-zag boyeau, according to the line of its direction with respect to the general front of the works attacked. [Trench.]

BOYLE'S FUMING LIQUOR. This compound which is identical with hydrated *bisulphide of ammonium* is obtained by passing sulphur and ammonia through a red hot porcelain tube; or by igniting together 3 parts of slaked lime and 2 of sulphur, and then distilling 3 parts of the product with 2 of chloride of ammonium and 1 of sulphur. It is a yellow fœtid oily liquid which often deposits lamellar yellow crystals on cooling. It is decomposed by acids with the evolution of sulphuretted hydrogen and deposition of sulphur.

BRACELET. [Armilla.]

BRAHMA, a Sanscrit word, the name of the Supreme Being in the religious system of the Hindoos. The primitive meaning of the word is not quite clear; it is evidently connected with the verbal root *brīh*, "to grow, to expand," whence *brīhat*, "great;" and has been explained by some as properly implying "the widely expanded Being." The crude form of the word, or the name in its uninflected state, is *Brahman*, and it is of great importance well to distinguish a two-fold use of that term, accordingly as it is declined as a substantive of the neuter or of the masculine gender. When inflected as a substantive of the neuter gender, its termination in the nominative case is a *short a*, *Brahmă* (sometimes written *Brahme* or *Brahm* in English works on Hindoo mythology), and thus declined it designates the essence of the

Supreme Being in the abstract, devoid of personal individuality. When treated as a masculine word, it takes a *long ā* in the nominative case, *Brahmā*, and thus modified, becomes the name of the first of the three gods who constitute the trimurti or triad of principal Hindoo deities.

Brahmă, the impersonal divine substance, is with the Hindoos not an object of worship, but merely of devout contemplation, and he is addressed as Om, or Aum, a reverential word, which no Hindoo pronounces aloud. According to the Vêdânta system of philosophy, which recognises the ancient sacred writings of the Hindoos as the authority of the doctrines which it advances, Brahmă is the great source from which the visible universe and all the individual deities of mythology have sprung, and into which all will ultimately be re-absorbed. "As milk changes to curd, and water to ice, so is Brahmă variously transformed and diversified, without aid of tools or exterior means of any sort. In like manner, the spider spins his web out of his own substance; spirits assume various shapes; and the lotos proceeds from pond to pond without organs of motion." "Ether and air are by Brahmă created; but he himself has no origin, no procreator nor maker, for he is eternal, without beginning as without end. So fire, and water, and earth, proceed immediately from him, being evolved successively the one from the other, as fire from air, and this from ether." The human soul, according to the same authority, "is a portion of the supreme ruler, as a spark in the fire. The relation is not as that of master and servant, ruler and ruled, but as that of whole and part." It is subject to transmigration, and the route on which, after the death of the human individual, it proceeds to its ultimate re-absorption in the divine essence, is variously described in divers texts of the Vêdas. "But he who has attained the true knowledge of God does not pass through the same stages of retreat, proceeding directly to reunion with the Supreme Being, with which he is identified, as a river, at its confluence with the sea, merges therein altogether. His vital faculties, and the elements of which his body consists, are absorbed absolutely and completely; both name and form cease; and he becomes immortal, without parts or members." (Passages from the 'Brahma-sûtras,' or aphorisms on the Vêdânta doctrine, by Bâdarâyana, translated by Mr. Colebrooke; 'Transact. of the Roy. Asiat. Soc.,' vol. ii. passim.) The Vêdas do not teach hero-worship, and make but slight allusions to the incarnations or avatars, which have so largely increased the number of gods. The Vêda was succeeded by the Vêdânta, and that by the Puránás, each becoming less monotheistic, until the Puránás have ended in a pantheistic idolatry.

Brahmā, as an individual deity in mythology, though originally represented as the almighty creator, preserver, and destroyer, has subsequently become three distinct beings, as Brahmā the creator, with Vishnu the preserver and sustainer, and Siva the destroyer. His epithets are numerous, and the following are some of those given by Mr. H. H. Wilson: *Viswábhavána*, the creator of the universe; *Mahá purushá*, great or supreme spirit; *Imdriyátmá*, one with (or lord of) the senses. But exclusive worshippers of Brahmā and temples dedicated to him do not now seem to occur in any part of India: homage is however paid to him along with other deities. The Brahmans, in their morning and evening worship, repeat a prayer addressed to Brahmā; and at noon likewise they go through certain ceremonies in his honour: on the occasion of burnt offerings, an oblation of clarified butter is made to him, but it does not appear that bloody sacrifices are ever offered to Brahmā. In the later Puránás, as in that of 'Bhagavat Dasam askand,' translated by Theodore Pavie, Vishnu or Krishnu, and Siva, rise into independent deities; and as they represent the principles of good and evil, a continued contest is the result. The other deities, of whom there are numbers, are now represented as having been either avatars of Brahmā in the form of Vishnu, or his descendants either immediately or from Vishnu or Siva. Brahmă, in the earlier Vêdas, is stated to have preceded the existence of matter; but Vishnu is at once Purusha (spirit), Prudhána (crude matter), Vyakta (visible form), and Kála (time); and the acts of creation, preservation, and destination came to be allegorised into personages. At the full moon of the month Mâgha (January-February), an earthen image of Brahmā, with that of Siva on his right and that of Vishnu on his left hand, is worshipped; and dances, accompanied with songs and music, are performed as at the other Hindoo festivals. When the festivities are over, the images of the three gods are cast into the Ganges. A particular worship is paid to Brahmā at Pushkara or Pokher in Ajmere, and at Bithore in the Dooab, where he is said to have performed a great and solemn sacrifice on completing the act of creation; and the pin of his slipper, which he left behind him on the occasion, and which is now fixed in one of the steps of the Brahmaverta Ghat near Bithore, is still an object of adoration there.

(H. H. Wilson, *The Vishnu Puráná, a System of Hindu Mythology and Tradition*, 1840; Pavie, *Krichnu et sa doctrine*, Paris, 1852; Count M. F. F. Björnstjerna, *Die Theogonie, Philosophie und Kosmogonie der Hindus*, Stockholm, 1843.)

BRAHMANS. [HINDOOS, CASTES OF.]

BRAIN, DISEASES OF. The morbid conditions of the brain are of great importance, and will be found treated of in this work under the various heads of the most distinctive forms which these diseases assume. They will be found under the following heads:—APOPLEXY, CONVULSIONS, CHOREA, DELIRIUM-TREMENS, ENCEPHALITIS, EPILEPSY, HYSTERIA, INSANITY, MENINGITIS, PARALYSIS.

BRAKE, or BREAK, in Machinery, a contrivance for retarding or arresting motion, by creating an amount of friction too great to be overcome by the moving power, or the momentum of the machine. Brakes generally consist of blocks of wood so connected with a system of levers or screws that they may be pressed firmly against the periphery of a wheel mounted upon the main axle of the machine; but in some cases, instead of a block of wood, a strap or belt of iron, of sufficient length to embrace one-half of the periphery of the brake-wheel, or a series of small blocks of wood attached to the concave surface of such a strap, is used. [SAW-MILL; ROLLING STOCK; WIND-MILL.]

BRAMAH'S PRESS. [HYDRAULICS.]

BRAMINS. [HINDOOS, CASTES OF.]

BRAND IN CORN. [BURNT-EAR.]

BRANDY. This well-known liquid is the alcoholic or spirituous portion of wine, separated from the aqueous part, the colouring matter, &c., by distillation. The word is of German origin, and in its German form, *brantwein*, signifies burnt wine, or wine that has undergone the action of fire. Brandies however have been made from potatoes, carrots, beet-root, pears, and other vegetable substances; but these varieties are all inferior to true brandy. Brandy is prepared in most wine countries, but that of France is the most esteemed. It is procured not only by distilling the wine itself, but also by fermenting and distilling the *marc* or residue of the pressings of the grape. It is procured indifferently from red or white wine; and different wines yield very different proportions of it, the strongest of course giving the largest quantity. Brandy obtained from marc has a more acrid flavour than that from wine; this appears to be occasioned by an oil contained in the skin of the grape, which when separated proves so acrid that a single drop would deteriorate several gallons of good brandy. The celebrated brandy of Cognac, a town in the department of Charente, and that brought from Andraye, seem to owe their excellence to being made from white wine, so fermented as not to be impregnated with this oil. Like other spirit, brandy is colourless when recently distilled. By mere keeping, however, owing probably to some change in the soluble matter contained in it, it acquires a slight colour, which is much increased by keeping in casks, and is made of the required intensity by the addition of burnt sugar, or other colouring matter.

The production of brandy, so far as obtaining the alcoholic principle is concerned, is described under DISTILLATION.

Although brandy drinkers despise patent or British brandy, yet it is a question whether this may not be quite as pure and strong as much that goes by the name of foreign brandy. So enormous is the duty paid on foreign brandy, that the French manufacturers are induced to strengthen their cognac artificially by spirits of wine, and the English dealers to increase its bulk by water and other additions. Foreign brandy ought to be a little 'over proof;' but it is frequently 12 to 15 degrees below proof. Dr. Normandy makes the following remarks on the worst or really fraudulent brandy:—"Brandy, when newly distilled, is white; but that met with in commerce is always of a yellowish, brown, or dark brown colour, due to the presence of some extractive matter, and of tannic acid, which it has dissolved from the oak casks in which it has been kept for a long time. But in order to simulate this colour of genuine brandy, the brandy of commerce is nothing else than new brandy or alcohol, at once converted apparently into old brandy by means of caramel, or burnt sugar."

British brandy, for which patents have been obtained by many English distillers, is the result of numerous attempts to produce, from malt spirit, a liquor that shall bear a close resemblance to foreign brandy. The best malt spirit is the basis of all the British brandies; and the flavour, colour, and degree of strength, are brought about by the addition of some among the following long list of ingredients: water, red tartar, acetic ether, French vinegar, French plums, wine-bottoms, tincture of catechu, oak shavings, bitter almonds, burnt sugar, tincture of vanilla, oil of cassia, rum, &c.—each manufacturer having a favourite recipe of his own. It is said that where black tea is cheap, as in America, it is often employed to give an imitative brandy-roughness to coloured spirits.

Brandy is an ingredient in a large number of cordials and liqueurs, such as cherry brandy, carraway brandy, lemon brandy, orange brandy, peach brandy, raspberry brandy, and the like. They all bear a family resemblance in so far as they consist of brandy, flavoured by the fruits or seeds whose name they bear, sweetened with sugar, and rendered fragrant with spices.

Regarded in its commercial features, brandy is a commodity of considerable importance. In all wine-producing countries, a part of the produce of the vineyards is converted into brandy; and in some of those countries a portion of the spirit is employed to give strength to the remaining portion of the wine. The fiery wines of Spain, Portugal, Madeira, the Cape of Good Hope, and other countries, are thus treated. There are no certain means of knowing what proportion of the produce is distilled in different places. The only country in which, as far as we know, any estimate of this kind has been made, is France; where a commission, appointed to inquire concerning the duties levied upon liquors, has given an estimate of the produce of the vineyards, and the mode of its disposal. From this it appears that about 15 per cent. of the wine is made into brandy; but as the spirit obtained varies in quantity according to the quality of the wine from which it is made, it is not possible to state its amount with precision. It has been estimated

that the quantity of brandy annually made is equal to about 20,000,000 English gallons, of which about one-third is exported, leaving 13,000,000 gallons for consumption in France. The principal exportations are made from the Charente, from Bordeaux, and from the port of Cette in the Mediterranean. From Charente comes the brandy of Cognac, which is principally used in England, to which country three-eighths of all the shipments of French brandy are ordinarily made; about one-fourth is taken by the Americans, chiefly from Bordeaux and Cette; and the remainder is shipped, in comparatively small quantities to the French Antilles, to India, and to various countries in Europe, chiefly to the north. Until the early part of the present century, considerable purchases of Spanish brandy were made by the English government for the use of the navy; but at that time, with the view of encouraging our West India colonies, rum was substituted. The shipments of brandy from Spain are principally made at Barcelona, whence about 11,000 pipes (about 1,200,000 gallons) are annually exported. Of this quantity 3000 pipes are sent to Cuba, 6000 pipes to the former dominions of Spain in America, and 2000 pipes to the north of Europe.

The consumption of brandy in England was greater seventy years ago than it was twenty years ago, owing chiefly to the raising of the duty from 6*s*. to the enormous amount of 22*s*. 6*d*. per gallon. In estimating the import, it is necessary to distinguish between the portion retained for home consumption and the portion re-exported to India and the colonies. The following figures exhibit the total imports in the last three years; but it must be borne in mind, that the quantity entered for home consumption, plus the quantity re-exported, do not necessarily amount together to the quantity imported; seeing that a considerable portion may remain in bond, under the charge of the Customs' department, awaiting the time when the owner may choose to pay the duty for home consumption. The quantity entered for home consumption and the quantity re-exported may, in other instances, exceed the quantity imported in that year; in such case the reserve stock of the previous year must have been drawn upon.

	Quantities Imported.	Entered for Home Consumption.
	Proof Gallons.	Proof Gallons.
1856	2,540,438	1,534,694
1857	2,899,952	1,291,499
1858	1,064,661	1,108,105

The quantities re-exported were as follow:—

	Proof Gallons.
1856	1,539,075
1857	1,047,763
1858	671,474

The brandy trade of these three years exhibited strange fluctuations, as will be evident from an inspection of the above figures.

British or imitative brandy is among the alcoholic liquors which pay excise duty.

BRANK. [Buck Wheat.]

BRASS, Æs of the Romans, is an alloy of copper and zinc, which has been known and used from the remotest antiquity; it is now extensively employed both for useful and ornamental purposes.

The direct method of forming brass is by melting together its constituent metals; but it was manufactured long before zinc was obtained in its metallic form. Calamine, an ore of zinc, was mixed with copper and charcoal; and the zinc being, by the well-known action of the carbonaceous matter, reduced to the metallic state immediately combined with the copper, without separately exhibiting metallic properties. In Germany brass appears to have been made for centuries before the manufacture was introduced into England: this is stated to have been done by a German, who established works at Esher in Surrey in the year 1649.

When the requisite furnaces have been erected, the next step in the process is that of reducing copper to a convenient form for ensuring its ready combination by extending its surface. This is effected by pouring the melted metal into water; by which process what is called *shot copper* is obtained, in pieces varying in size from that of small shot to that of a bean.

The next process is to prepare the calamine, which is a carbonate of zinc. This is first broken into small pieces, and then heated to redness in a reverberatory furnace. In this way, by the loss of carbonic acid and moisture, one ton of calamine is generally diminished to about twelve cwt., and it is when cold reduced to a fine powder and washed.

The materials being thus prepared, 45 pounds of the shot copper, 60 pounds of the powdered calamine, and a quantity of powdered charcoal equal to it in bulk, are carefully mixed and put into eight earthen crucibles, this being the number placed in each furnace, made of a peculiar form. There is also commonly mixed with these ingredients a quantity of scrap brass. When the fire has been continued for about seven or eight hours, the operation is finished. Supposing 40 pounds of scrap brass to have been added to the above-mentioned quantities of the ingredients, a plate of brass is obtained by pouring the metal into granite moulds, which is generally about 5½ ft. in length and weighs about 108 pounds. This plate is used for rolling into thin sheets called latten. Very frequently the metal is poured into cast-iron moulds, by which bars about eight inches in length are obtained: these bars are employed by those who cast brass into small goods, or who mix it by melting with additional quantities of copper so as to produce metal having different shades of colour, as tombac, pinchbeck, &c. Sometimes blende, or the sulphuret of zinc, is employed instead of calamine; it is first roasted to dissipate the sulphur, and there remains an oxide.

Such is the process formerly employed, and even still occasionally used for the manufacture of brass, but it is now almost universally made by the direct fusion of its constituent metals, copper and zinc. 51 lbs. of old brass free from solder, 55 lbs. refined and granulated copper, and 24 lbs. of zinc are melted together in four crucibles, the loss being about 2½ to 4 lbs. upon the total quantity.

Brass for various purposes is made of different proportions of the two metals, and consequently possesses different qualities; its general properties are, that it has a well-known fine yellow colour, is susceptible of receiving a high polish, and is only superficially acted upon by the air. It is very malleable and ductile when cold, and consequently may be beaten into thin leaves and drawn into fine wire: at a high temperature it is brittle. The specific gravity of brass is greater than that deducible from the specific gravities of the metals which constitute it, as shown by the following statement.

Brass, containing copper 70 and zinc 30, would give a calculated specific gravity of 8·390; but by experiment it is found to be 8·443: when the proportions are copper 80 and zinc 20, the calculated is to the actual density as 8·490 to 8·560. On comparing the composition and density of different kinds of brass, it appears that the density increases with the proportion of copper, as might indeed be expected, and that it is sometimes even equal to that of the copper itself.

Brass is more fusible, sonorous, a worse conductor of heat, and harder, than copper. It is readily turned in a lathe, and is consequently well adapted not only for philosophical instruments, but those used in manufacturing processes and for domestic purposes. In the state of wire it is most extensively employed in pin-making, and for various other purposes; the thin leaves into which brass is made by hammering are called Dutch metal or Dutch gold.

Authors differ widely as to the best proportions of copper and zinc for making brass. It is stated, in the supplement to the 'Encyclopædia Britannica,' that one part of copper and two parts of zinc are the best proportions for common brass; and that one part of each forms prince's metal of a fine yellow colour. Mr. Parkes, 'Essays,' p. 210, states (and we believe he obtained his information from an accurate source) that the most useful proportions are two parts of copper to one part of zinc, which are not far from one equivalent of each metal. Berthier's analysis of the brass wire of Jemappes confirms the probability of this statement, for he found it to consist of—

Copper	64·2
Zinc	33·1
Lead	·8
	98·1

The small quantity of lead is, of course, to be regarded as an accidental admixture. Bristol brass consists of—

Copper	65·15
Zinc	34·85
	100·00

Some old Dutch brass, much approved of by watchmakers, contained

Copper	69·55
Zinc	30·45
	100·00

Mr. D. Forbes has observed that a silver-white brass may be formed by alloying seven equivalents of copper with eight equivalents of zinc; but if the quantity of zinc be either increased or diminished, the alloy has the usual colour of brass.

The following table exhibits the composition of several other varieties of brass:—

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Copper	65·8	64·6	63·7	82	70·1	80	90·5	91·2	60
Zinc	31·7	33·7	33·5	18	29·9	17	7·9	5·6	40
Lead	2·2	1·5	·3	—	—	—	1·6	1·4	—
Tin	·2	·2	2·5	—	—	3	—	1·8	—
	99·9	100·0	100·0	100	100·0	100	100·0	100·0	100

No. 1. is brass from Stolberg in Germany, and No. 2. from Jemappes in France; both are well adapted for the lathe, and are highly esteemed. Nos. 3. and 4. are recommended by D'Arcet for gilding; they fuse easily, can be chased or turned with facility, and take up little gold in the gilding operation. No. 5. is perfectly free from lead and tin, and consequently works well under the hammer; it is made at Romilly, and is much esteemed. No. 6. is employed in France for ornamenting fire-arms; its colour is good, and it is very permanent in the air. No. 7. Chrysocolla. No. 8. Statuary brass. A statue by the brothers Keller in the palace of Versailles is cast from this brass. No. 9. Muntz metal, used for sheathing ships, admits of being rolled while hot.

In concluding this article, we shall give the method of analysing brass proposed by Mr. Keates, in the 'Annals of Philosophy,' vol. iii. N. S., p. 326.

Dissolve the brass in dilute nitric acid, add a little sulphuric acid, and evaporate to dryness; redissolve in excess of dilute sulphuric acid, dilute the solution, and boil pieces of polished iron in it, until the solution becomes nearly colourless; filter it while hot, wash the precipitated copper with dilute sulphuric acid, and afterwards with boiling water: this, when dried, is to be put into a crucible, covered with charcoal powder and melted; the copper being cleansed from any adhering charcoal, is then to be weighed.

The filtered solution, from which the copper has been separated, is to be boiled with nitric acid to peroxidise the iron; neutralise the acid with carbonate of soda, and precipitate the iron by ammonia, using an excess of the latter so as to redissolve the oxide of zinc at first precipitated; filter the solution, and add to it hydrochloric acid, evaporate to dryness, and heat the dry mass in a platinum crucible to drive off the chloride of ammonium; dissolve the residuum in dilute hydrochloric acid, and precipitate by carbonate of soda; the precipitate, after being washed and dried, is heated to redness; every 40·5 parts of this precipitate is equal to 32·5 parts of metallic zinc.

Another and more simple method is the following: Dissolve the brass in a considerable excess of nitric acid; pass sulphuretted hydrogen gas, also in excess, through the solution; the copper only is precipitated, which is to be treated with nitric acid, the sulphur separated by filtering, and the oxide of copper precipitated by boiling with soda: 39·7 grains of this precipitate indicate 31·7 grains of copper.

The solution remaining after the separation of the sulphuret of copper is to be boiled to expel the excess of sulphuretted hydrogen, and then precipitated by carbonate of soda: the precipitate, when ignited, is oxide of zinc, 40·5 grains of which indicate 32·5 grains of metallic zinc. (Smith in 'Lond. and Edin. Phil. Mag.' vol. viii.)

The general properties of brass are, a fine yellow colour, a susceptibility of a high polish, and a power of being only superficially acted upon by the air. It is brittle at a high temperature, but very malleable and ductile when cold. Its specific gravity is greater than that deducible from the specific gravities of its constituent metals. It is more fusible than copper, a worse conductor of heat, and harder. The facility with which it may be cast, and turned in a lathe, or otherwise worked, renders it peculiarly useful in the construction of mathematical instruments, and the smaller parts of machinery. Brass wire is extensively used in pin-making, and for various other purposes. *Latten* is a name sometimes given to thin sheets of rolled brass; and *Dutch metal*, or *Dutch gold*, is brass beaten out into very thin leaves.

A mode of using sheet brass or other metal for ornamental purposes was introduced a few years ago, in which the appearance of solid metal might be obtained without the weight, by using a wooden core to place the sheet metal upon. The method is useful for making cornice-poles, mouldings, or other articles of continuous form and pattern. The wood is first shaped, by planes and other tools, to the required pattern; the sheet metal is placed upon it; and the two together are drawn through a suitable die, which unites them by driving the edges of the metal into the substance of the wood. If the pattern be a plain one, it is struck down upon the wood by the die through which it passes; but if the pattern be full and complicated, it is imparted to the sheet metal by swaging tools and dies, previous to the application of the metal to the surface of the wood.

The ordinary mode of making brass tubes is as follows: A tube is first cast much shorter and thicker than will ultimately be required; this is drawn through dies differing in diameter by degrees, until it is reduced to the required size of bore. The brass is annealed from time to time, to enable it to bear the successive drawings; and it is lastly "pickled" in dilute acid, to remove the scales and discoloration. In 1851, Mr. Green patented a method by which the annealing and cleansing might be more carefully attended to in making the brass tubes for the boilers of locomotives.

Not only are the filings and turnings of brass sold for re-melting, but the very ashes of the furnaces in which the brass has been melted find a market—there being in them a sufficient per-centage of metal to pay the expense of smelting.

The brass manufacture is one of the most important of the branches of industry at Birmingham. Lamps, chandeliers, tubes, pipes, gas-fittings, bedsteads, cornices, frames, and numberless other articles, are now made largely in this metal. One of the brass factories, the Cambridge Works, presents a fine example of organisation applied to a special department of industry. Some of the stamping works, also, are noteworthy for the extraordinary number of dies or moulds kept in store for stamping articles in sheet brass.

After supplying home demand, there is a surplus of brass and brass goods for exportation: in the last three years the quantities and values exported were as follow:—

1856 . .	19,198 cwts.	£121,206 value
1857 . . .	26,960 ,,	143,953 ,,
1858 . .	26,554 ,,	155,293 ,,

BRASSES, MONUMENTAL. By "a brass," as the term is commonly used, is meant a plate of brass, which has been imbedded in a stone slab, and fastened down by being laid in melted pitch and riveted through the stone. The effigy of a person deceased is usually engraved on the brass plate; but brasses are not uncommon in which a foliated or ornamented cross or symbolical device occurs instead of a human figure. In the brasses with figures there is frequently a canopy over the head, and there are often armorial bearings, angels, saints, and other ornaments, together with inscriptions, sometimes on labels, sometimes round the border of the slab, but mostly below the feet of the effigy. These separate parts have been, in almost all cases, engraved on detached plates, each of which is inlaid in its own cavity of the stone. The engraved plates were not originally in the plain state in which they now appear, but were generally burnished and sometimes gilt, and the incised parts were filled with black or coloured resinous substances, and for the heraldic *argent* metal resembling pewter: very rarely enamel was used, as in the celebrated brass of Sir John d'Abernoun, in Stoke d'Abernon church, Surrey. The plates were sunk level with the surface of the stone, which was generally of a dark colour, and thus became an appropriate background, giving distinctness and relief to the engraved brasses, and adding to the beauty of the figures and ornaments. Slabs with brasses are commonly laid in the pavement of churches or cloisters, but are sometimes on table tombs.

The art of engraving the plates was probably brought to England from Flanders and France, as well as in the earlier periods the plates themselves: the brasses of Cologne appear to have been held in most repute. Early brasses still exist in this country which are known to have been engraved by Flemish artists, and there are many fine brasses still remaining in the churches of Flanders; those of France were for the most part destroyed during the Revolution, when they were converted into coin or cannon; a very few remain in Germany; a few also of foreign manufacture are found in Denmark and Sweden; one in Spain (at Seville); in Italy there is not we believe a single example.

It is impossible to determine when monumental brasses were first introduced into England, most of the oldest specimens having doubtless been destroyed. Brasses with dates as early as about 1208 (as that of Simon de Beauchamp, at St. Paul's, Bedford), are known to have existed. The earliest now remaining in England are those of Sir John d'Abernoun, at Stoke d'Abernon, 1277, and Sir Roger de Trumpington, at Trumpington, Cambridge, who died in 1289. During the 14th century monumental brasses became more and more numerous; in the 15th century they were in still greater abundance; but towards the close of the 16th the number began to diminish, and they were of a very inferior quality. In the reign of James I. the use of them had become infrequent; and by the close of the 17th century they had almost passed out of date, though two still exist at St. Mary Cray, Kent, of much later dates, namely, to Philadelphia Greenwood, 1747, and to Benjamin Greenwood, 1773. Instances occur of engravings on the backs of brasses; in some cases apparently being unused brasses, but more frequently palimpsests. The number of brasses now remaining in England, though still considerable, is small compared with what it has been. Many were destroyed when the monasteries were suppressed in the reign of Henry VIII.; many have been torn up, and sold as old metal; but the greatest destruction of them took place during the predominance of the Puritans, who regarded them as superstitious, and the neglect, or worse, of subsequent times: the extent to which their destruction has been carried, is but too plainly shown in such a statement as that quoted by the Rev. C. R. Manning, in his chapter on brasses, in Mr. Paley's 'Manual of Gothic Architecture,' that "the pavement of York minster alone contained in the year 1612 one hundred and twenty brasses, of which one hundred and nineteen have disappeared." Probably in few other churches has the destruction been carried quite so far, but everywhere it has been very great. There still remain, however, upwards of two thousand brasses in this country. (Manning's 'List of the Monumental Brasses remaining in England,' and the works referred to below.)

The effigy on a monumental brass is generally represented recumbent on the back, with the hands on the breast placed palm to palm, in the attitude of prayer; and this form applies equally to men and women; but occasionally the figure is represented standing or kneeling. The head usually rests on a cushion, which is sometimes supported by an angel on each side. Military noblemen are generally in full armour; ecclesiastics in the vestments peculiar to their order; ladies have frequently a small dog lying at the feet, probably to typify their affection and fidelity, as the lion at the feet of the knights is typical of courage and nobility. The canopies and other engraved architectural embellishments are often extremely elegant. The canopy is sometimes a pediment with pinnacles and finial; sometimes a foliated arch; and sometimes a foliated arch below a pediment; the canopy is sometimes isolated, and sometimes rests on slender pillars. Occasionally armorial bearings are placed on the pillars and spandrils, of which a specimen is shown in the beautiful brass in Westminster Abbey, of Eleanor de Bohun, wife of Thomas of Woodstock, duke of Gloucester, son of Edward III. The shields of arms, devices, and peculiarities of costume, appropriate each brass to its period in a remarkable manner; and brasses in their turn are found of almost inestimable value in ascertaining the peculiarities of costume, arms, &c., of the several periods of English history. Each period has also a form of alphabetic character almost peculiar to itself, which, in the early brasses, is adhered

to with singular uniformity. Some inscriptions in the Gothic letters are very handsome. Roman letters are rarely used before the reign of Henry VIII., and are generally inelegant enough. The Gothic forms continued to be used occasionally till a late period. Most of the early

inscriptions are in Latin. French inscriptions occur generally from 1350 to 1400. English inscriptions afterwards became more common, but Latin still continued to be frequently used, and there are a few examples of inscriptions in Greek.

Monumental brasses in England have been most abundant in the eastern counties and Kent, partly perhaps in consequence of the contiguity of these counties to the Continent, whence the use of brasses seems to have been introduced, and partly of the want of stone suitable for the effigy in relief, for which the brasses appear to have been substituted. In Wales and the north of England brasses are comparatively rare; only one has been found in Scotland, namely, in Glasgow cathedral; and only two in Ireland (dated 1527 and 1528), in Dublin cathedral. Within the last few years, as a part of the revival of mediæval forms, monumental brasses have again come into use, and many very beautiful brasses have been laid down.

Specimens of monumental brasses are easily obtained by the process called *rubbing*. Paper of moderate thickness, tenacity, and softness, is laid upon the brass, and rubbed with a black or coloured material, which adheres to the paper where the brass is solid, leaving it in its original state where there are incisions, which of course offer no resistance to the rubber. With a little care a perfect fac-simile may be obtained. Shoemakers' heel-ball, or pouch-ball, which is a composition of tallow, wax, and lamp-black, is a very convenient rubber; the operation is clean and easy. Paper of suitable quality and of the full size of a whole slab is manufactured on purpose, as well as suitable heel-balls: but the whitest kind of lining paper used by paper-hangers answers very well.

Another material for making rubbings has been invented by Mr. H. S. Richardson, which is composed of a yellow metallic powder mixed with the adhesive substance of which the rubber is composed, as the lamp-black is mixed with the tallow and wax. When the rubbing is made on a dark-coloured paper, a fac-simile is obtained not easily distinguishable from the original; the figure appears to be the brass itself, and the paper which remains unacted on by the rubber seems to be the stone slab in which the brass is imbedded. Where great sharpness is required, a mixture of black-lead and linseed-oil applied with a rubber of wash-leather on thick tissue paper is found serviceable.

The first collection of copies of brasses was made by Sir John Cullum, Craven Ord, and the Rev. Thomas Cole, not by rubbing in the manner just described, but by a rude process resembling copper-plate printing, which was afterwards worked over by the pen, and cost much time and labour. The collection was sold for 43*l.* to the late Francis Douce, and was bequeathed by him to the British Museum, where it is now in the print-room. A few examples of brasses are preserved in the museums of the Department of Science and Art, at Jermyn Street and South Kensington.

'A Series of Monumental Brasses, extending from the reign of Edward I. to that of Elizabeth, by J. G. and L. A. B. Waller,' is the standard work on monumental brasses; the selection of specimens is very judicious, the plates are exceedingly accurate, and the work is accompanied by explanatory letter-press. See also the Rev. C. Boutell's 'Monumental Brasses and Slabs,' and 'Monumental Brasses of England;' and the 'Oxford Manual of Brasses.'

BRASSIC ACID. [Colza, Oil of.]

BRAVU'RA, in Music (Ital., *courage, intrepidity*), an air consisting chiefly of difficult passages,—of divisions, in which many notes are given to one syllable, therefore requiring great spirit, much *bravery*, in the performer. (See, under the word Air, *Aria di Bravura.*)

Compositions of this sort have generally no object but the display of the singer's force, volubility, and distinctness of articulation; though some few fine airs of the kind, by Handel, Hasse, Piccini, Guglielmi, Cimarosa, Mozart, &c., still keep alive a taste for this species of vocal music, and thus inferior works in the same style continue to be tolerated.

BRAZIL WOOD, *Colouring matter of.* Commercial Brazil-wood (*Pernambuco-wood, Sappan-wood, Bukkumwood, Saint Martha-wood, Wukkum-wood*), the product of several species of Cæsalpinia, nat. ord. Leguminosæ, yields its colouring matter [*Brezilin*] to water. The decoction, fine dark red, deepens in colour and improves by age and fermentation. It is used in dyeing and calico-printing as a spirit colour. It furnishes a crimson almost equal to cochineal, but much less permanent. The colouring matter readily combines with alumina or oxide of tin. It is changed to a permanent yellow by the action of dilute acids. Alkalies give it a beautiful purple hue that unfortunately is very transient. Brazil dye may be obtained in a fit state for printing by concentrating the decoction to a quantity about equal in weight to the wood used, precipitating the dun colouring matter with skim milk, and thickening the liquor, cleared by standing, with British gum. Sulphuretted hydrogen and sulphurous acid decolorise decoction of Brazil-wood—strong acids restore the red tint.

According to Chevreul, brezilin crystallises in small orange needles. It is partly volatilised, partly decomposed by heat. Nitric acid partially converts it into picric acid. It is soluble in water, alcohol, and ether. Salts of lead and tin give with it a coloured precipitate; solution of alum precipitates a red lake. It is possible that brezilin is identical with hematin.

BREACH, the opening formed either by breaching batteries or mines in the rampart of a fortress, to enable the assaulting column to enter. When formed by artillery, the breaching batteries are placed as nearly opposite the place of the desired breach as practicable, in order that the fire of the guns may be nearly perpendicular to the face of the masonry; it is then directed on the escarp revetment, so as to cut a horizontal groove in the masonry of the length of the desired breach, about 80 to 100 feet, at about half or one-third of the height of the revetment from the bottom, if there is no chance of the defenders being able to clear away the *débris*, or about three or four feet above the bottom of the ditch if this be feared. From each extremity of this horizontal groove, two vertical grooves are then made to detach this portion of the masonry wholly from the rest. The fire of the artillery is then directed generally over the detached portion, or what is still better, so as to make a series of vertical grooves parallel to the extreme ones, thereby isolating the counterforts. [Revetment.] The masonry then falling into the ditch, a few shells are fired into the rampart to bring portions of the earth down also, which, forming a species of ramp at an inclination of about 45°, the assaulting column is enabled to rush up into the works. In order to form a breach, guns of the heaviest calibre procurable are employed, and they should fire short ranges, to obtain the greatest destructive effect from the fire and accuracy in cutting the grooves. When time and matériel permit of it, the approaches are pushed close up to the works, and the breaching batteries established on the counterscarp. While the breaching batteries are being established and the breach made, a great gallery [Mines] is driven from the besiegers' approaches to the bottom of the counterscarp to give access to the ditch. When, however, from want of matériel the approaches cannot be pushed far enough forward, or from want of time it is not considered expedient to defer the formation of the breaching batteries till the covered-way is crowned, as occurred in most of the sieges in the Peninsula, the breaching batteries are established at some distance from the place, and their fire is consequently not nearly so effective; for not only is the possibility of striking accurately rendered much less, but if the escarp wall should be well covered by the glacis, the shot, in order to strike the wall low down, will have to be fired with small charges, which giving smaller velocities, and therefore a more curved trajectory, pass over the crest of the glacis. At the same time, being

much less certain and effective, a great expenditure of ammunition is entailed, and in fact it is very doubtful, judging by experience, whether anything is gained by thus pressing on sieges. At the same time it must be remarked, that in many old fortresses, the escarp is very much exposed, that is, not well covered by the glacis, especially from some commanding height in the neighbourhood, and in this case there will of course be little necessity for establishing breaching batteries close, and they have occasionally been effective as far as 1000 or 1200 yards.

No precise rule can be given, either as to the length of time or amount of ammunition required to make a breach, as both will vary much under different circumstances. The French, in their siege of Antwerp in 1832, made a breach 80 feet in width with six 24-pounders, from a distance of 55 yards in 34 hours, with an expenditure of 1288 rounds. The English, at the siege of St. Sebastian, to form the main breach, 100 feet in width, used ten guns at a distance of 620 yards, and took 95½ hours, with an expenditure of 13,000 rounds. In the former case we have 16 shots per running foot of breach, and in the latter 130. At Metz, in forming an experimental breach, only 4 shots were required per running foot. In this case, however, the disturbing circumstances of being under fire were wanting to make it a good guide. To form a breach in a revetment, such as that proposed by Carnot (a detached wall covered by an earthen rampart in front), is still more difficult, and was at one time considered impracticable. It was, however, demonstrated by experiments at Woolwich, that it could be effected by heavy guns (68-pounder carronades, and 8-inch and 10-inch howitzers), firing, from a distance of 400 or 500 yards, shot and shell with small charges, at an elevation of about 10° or 15°. These passing over the earthen embankment, struck near the foot of the wall and made a breach 14 feet in width in six hours, with an expenditure of 1400 rounds. The limits of this article will not permit of any further details of this important subject. It is probable, however, that the increased range and penetration of the rifled cannon, at present being experimented on, will render the formation of breaches an easier and more certain operation.

Breaches are occasionally, when the flanking fire is bad, or thoroughly subdued, formed by mining. In this case, a small party of miners is pushed across the ditch, and protecting themselves by blindages [BLINDAGE] from the effect of missiles thrown down upon them from above, proceed to push a gallery into the revetment, which, when it has gone far enough in, bifurcates to the right and left, where chambers are formed for the charges of powder, which are placed immediately behind counterforts, and require some nicety of adjustment as, if they are too large or too small a practicable breach is not made; and indeed at any time it is not a very certain method of forming a breach, as the *débris* of the masonry is usually in such large masses as to present a great obstacle to men attempting to mount.

Lodgments are formed on the breaches, either by open assault, or by the simple and bloodless method recommended by Marshal Vauban in his 'Traité des Sièges' [SIEGE], in which a few sappers, gradually working up under protection of the fire from the trenches, which are armed and kept ready to bring an overwhelming fire on the breach the instant the enemy makes an attempt to disturb them, form a lodgement at the top which, when ready, is occupied by parties in force.

The attack and defence of breaches has always been one of the most sanguinary and frightful of the operations of war. Every means that the ingenuity of man could devise has been at various times resorted to, to make the assault impracticable. The great breach at St. Sebastian was defended by deep pits dug in the ditch in front of the curtain; chevaux-de-frise made of well-tempered sword blades, were fixed in strong wooden beams planted on the top of the breach, while rows of 14-inch shells and powder barrels were laid on the ground at the foot of the breach, and fired by a powder-hose; and during the interval between the cessation of the fire and the assault, the defenders had thickly strewn the ascent with harrows, and planks with nails in them. At the same time cuts were made in the neighbouring parapets, from which a continuous fire of musquetry was directed on the ditch and foot of the breach. The following curious method of defending a breach is mentioned in Vauban's 'Traité de la Défense des Places:' At the siege of Chatté, a small town in Lorraine, on the Moselle, by Marshal de la Ferté, a tolerable breach having been made, and the garrison when summoned refusing to surrender, the assault was given. During the very height of the combat, the besieged took it into their heads to throw on to the breach five or six hives of bees which happened to be at hand, these, enraged at being so treated, attacked the besiegers and stung them so violently that they were forced to give up and retire into their trenches, where they followed them with such invincible obstinacy, that the trenches were deserted for several days, during which time the defenders repaired the breaches. This was one of the principal reasons for the siege being raised.

BREAD may be divided into two kinds: first, common biscuit bread, made merely from flour and water, without undergoing any fermentation, and which is consequently compact, heavy, and hard; secondly, loaf bread, formed of flour which has been fermented, and which is therefore porous, light, and soft. The seeds of wheat, barley, oats, and rye are principally employed, and in the state of flour, for the making of bread. These grains resemble each other sufficiently in their nature and properties to render it needless to treat particularly of the bread made from more than one of them; and as wheaten bread is most extensively used, and the properties indicating perfect bread most distinctly exhibited therein, our remarks will apply chiefly to it.

Common or unfermented biscuit bread, which was undoubtedly that first used in the early ages of the world, is made as described under BISCUIT; in this operation no chemical change takes place, but only the mechanical one of moistening the particles of the flour, so as to cause them to adhere in the first instance, and to remain in one mass by the subsequent process of baking.

In bread, properly speaking, the process of manufacture is one of much longer duration, and the chemical action of fermentation is produced in the mixture of flour and water. Wheat flour is composed chiefly of *starch* and *gluten*, with a small quantity of gummy sugar, and of vegetable albumen. Sir Humphrey Davy found, by certain investigations made by him, that wheat sown in autumn contained 77 per cent. of starch, and 19 of gluten; while that sown in spring yielded 70 of starch, and 24 of gluten. The wheat of the south of Europe contains a larger proportion of gluten than that of the north, and hence its peculiar fitness for making vermicelli. According to the distinguished chemist just quoted, oats yielded 59 of starch, 6 of gluten, and 2 of saccharine matter; while the same quantity of rye gave only 6·1 parts of starch, and half a part of gluten. Referring to other pages of the Cyclopædia for descriptions of these two substances, we will simply state here that both take part in the fermenting of dough into bread, and that each renders its own peculiar useful service to the human system when taken as food.

When flour, made into a paste or dough with water, is suffered to remain in a moderately warm place, it undergoes that partial and spontaneous decomposition which is called fermentation, and which, in order to distinguish it from other kinds, has been called, but without sufficient reason for the distinction, the *panary* fermentation. During this fermentation, a portion of the carbon and oxygen of the partially-decomposed flour recombine to form carbonic acid gas; this, during its natural tendency to escape into the air, is arrested in its progress through the dough by the adhesiveness of the gluten, and forms, owing to its retention, numerous cavities in it. It is thus that wheat-flour makes lighter bread than that of oats or rye, owing to the larger quantity of gluten which it contains, by which the bread is rendered more porous and lighter, and consequently more digestible.

This plan of fermentation would, however, require much time. Moreover, the dough thus spontaneously fermented is never quite free from putrescence and acidity, both of which are injurious to the flavour of the bread. To remedy these inconveniences, the process was formerly accelerated by adding to a mass of recent dough a small quantity of old dough in a state of strong fermentation; this was called *leaven*, and the mass to which it was added was said to be leavened. Although the use of leaven was an unquestionable improvement, a still further one was made by the employment of *yest*, or *yeast* instead of it; by this the fermentation is much more rapidly and perfectly effected. The exact nature of this ferment has not been ascertained. It is the frothy scum which rises on the surface of beer during its fermentation; it is a very complex substance, and appears to contain gluten; but that alone is not sufficient to account for the effects produced, as gluten is incapable of fermentation *per se*.

Many diversities exist in the art of bread-making; but the following will sufficiently exhibit the main features of the process, as generally conducted. In the water employed to make the dough, which varies in temperature from 90° to 100° Fahr., there is dissolved a certain portion of salt, the quantity of which, however, is always less than that which will finally be required; yeast is now mixed with the water, and then a portion of flour is added. The mixture is next covered up, and set apart in a warm situation; within an hour after which, signs of commencing decomposition make their appearance. The substance thus placed apart is termed, in the language of the bakehouse, the *sponge;* its formation and abandonment to spontaneous decomposition is termed *setting* the sponge; and according to the relation which the amount of water in the sponge bears to the whole quantity to be used in the dough, it is called *quarter*, *half*, or *whole* sponge. The sponge begins to swell out and heave up, in consequence of the generation of carbonic acid gas. If the sponge be of a semi-liquid consistence, large air-bubbles soon force their way to its surface, where they break and dissipate in rapid succession. But when the sponge possesses the consistence of thin *dough*, it confines the gas until expanded equably and progressively to nearly double its original volume: when, no longer capable of containing the pent-up air, it bursts and subsides. This process of rising and falling alternately might be actively carried on, and frequently repeated, during twenty-four hours; but the baker checks it at a particular point, to prevent the bread from becoming sour. He adds to the sponge the remaining proportions of flour and water and salt, which may be necessary to form the dough of the required consistence and size, and next incorporates all these materials with the sponge by a long and laborious course of kneading. When this process has been continued until the fermenting and the newly-added flour have been intimately blended together, and until the glutinous particles of the flour are wrought to such a union and consistence that the dough, now tough and elastic, will receive the smart pressure of the hand without adhering to it when withdrawn, the kneading is for awhile suspended. The dough is abandoned to itself for a few hours, during which time

it continues in a state of active fermentation, now diffused through its whole extent. After the lapse of this time, it is subjected to a second, but much less laborious kneading; the object of which is to distribute the gas engendered within it as equably as possible throughout its entire constitution, so that no part of the dough may form a soddened or ill-raised bread, from the deficiency of this carbonic acid gas on the one hand; or a too vesicular or spongy bread, from its excess on the other.

After the second kneading the dough is weighed out into the portions requisite to form the kinds of bread desired: these portions of dough are shaped into loaves, and once more set aside for an hour or two in a warm situation. The continuance of fermentation soon generates a sufficient quantity of fresh carbonic acid gas within them to expand each mass to about double its former volume. The masses are now considered fit for the fire, and are finally baked into loaves, which, when they quit the oven, have attained a size nearly twice as bulky as that at which they entered it. From the nature of the processes to which it has been exposed, a well-baked loaf is composed of an infinite number of cellules, each of which is filled with carbonic acid gas, and seems lined with or composed of a glutinous membrane; it is this which communicates the light elastic porous texture to the bread.

It has been already observed, that what is sometimes called the *panary fermentation* is not of a peculiar kind: it is the mere vinous fermentation; and Dr. Colquhoun has shown that it depends upon the saccharine ingredient of the flour, though its quantity compared with the others is so small. The fermentation is also probably aided by the conversion of a portion of starch into sugar, as happens in the well-known process of malting.

The nature of the yeast employed in bread-making is a subject of considerable importance: porter yeast is too bitter, but ale and table-beer yeast answer perfectly well. When these are deficient in quantity, yeast is manufactured by a process similar to that of brewing; a wort is made of malt, to which hops and brewers' yeast are added; by this yeast is obtained free from the bitterness which accompanies porter yeast. Carbonate of ammonia is advantageously and extensively used as a substitute for yeast in making the finer kinds of bread: it is a substance which is totally volatilised at a moderate temperature, and though extremely pungent to the smell, and possessed of a strong taste, it imparts neither taste nor smell to the bread, on account of its great volatility.

Salt is used in bread-making, not only for the sake of flavour and colour, but also to stiffen the clammy dough made from new flour. Good flour will bear a greater quantity of salt than bad, and new flour requires more than old, for the reason already stated.

When flour is converted into bread, it is found on weighing it when taken from the oven that it has increased from 28 to 34 per cent. in weight; but when it has been kept thirty-six hours, that which had gained twenty-eight will lose about four pounds. There are, however, several circumstances which influence the quantity of bread obtained from a given weight of flour, such as the season in which the wheat was grown and the age of the flour: the better the flour is, and the older, within certain limits, the larger is the quantity of the bread produced.

When it was found that the panary fermentation is identical in principle with the vinous, and that a little alcohol is produced by it, there arose a notable project, a few years ago, for saving the spirit produced in bread-making. A sum of 20,000*l.* was spent in establishing a bakery at Chelsea, but it was soon found that the projectors had very much misconceived the chemistry of their subject; while neighbouring bakers, by advertising "*bread with the gin in it*," contrived to throw the gin-less bread quite out of popular favour.

Under ordinary circumstances, no machinery is employed in bread-making in England; but patented contrivances do occasionally come into notice. Some years ago Mr. Clayton obtained a patent for a rotatory kneading-machine, in the interior of which knives were placed diagonally; and other mixing and kneading machines have since been invented; but the hand method remains still almost exclusively in force in this country. Our French neighbours understand these things better: they apply more science to the chemistry of eating and drinking. The mixing and kneading are generally effected by hand, but they are more carefully attended to than in England. There is, however, a machine bakery patented at Paris by M. Mouchot, of which Dumas gives a description: the lifting of the flour into the troughs, the admission of water, the mixing, the kneading, the baking, all are effected by the aid of efficient machinery.

A machine for baking bread by steam was introduced into France a few years ago. It consists principally of two concentric cylinders, the inner one of which has numerous perforations. The dough is placed in the inner cylinder, and the steam is admitted to the space between the two cylinders. Half an hour is said to be sufficient for the heat of the steam to bake the bread; but it would appear that there ought to be some mode of drying the bread after this process.

In respect to *ovens*, considerable improvements have been introduced within the last few years; instead of placing fuel *in* the oven, it is placed on one side, and flues are so arranged as to heat the oven with less waste, more quickly, and with more cleanliness than on the old method.

The public has been rendered justly indignant at the long list of objectionable substances used to adulterate bread;—damaged wheat, beans, peas, potatoes, plaster of Paris, chalk, pipeclay, burnt bones, are all said occasionally to take part in the manufacture of what ought to be wheaten bread. There is a double mischief in all this: it is a robbery in itself; and it leads to the honest as well as the dishonest being suspected by those whose suspicions are aroused, but who have neither inclination nor skill to analyse their bread. Salt, as was before observed, is really a necessity in bread-making.

The varieties of bread used only in a small degree are numerous. There are bran bread, French soup bread, grain bread, household bread, Iceland moss bread, leavened bread, potato bread, &c.—all of which have peculiarities either in the ingredients or in the mode of making.

The most recent and important novelty in bread-making is probably that of Dr. Dauglish, resulting from three patents taken out in 1856, 1857, and 1858, and put in operation at the machine bakery of Messrs. Peek and Frean. The "raising" of bread into a *sponge* is effected, not by fermentation, but by adding carbonic acid gas to the flour under great pressure. The flour is put into a strong thick iron globe; water saturated with carbonic acid gas is forced into it; kneading-knives rotate among the ingredients for a few minutes; the mixing, aërating, and kneading go on all at once; a trap at the lower part of the globe opens, the well-kneaded dough falls out in a thick, solid cylinder, or in a flat ribbon, according to the shape of the orifice; and this cylinder or ribbon of dough fashions itself into loaves of varied shape, according to the arrangement of simple apparatus beneath. The loaves are placed on trays, the trays are ranged on a travelling railway, and the railway conveys them swiftly and systematically into the oven, which is constructed and heated in a peculiar manner. Arrangements are made for the production of bread on a large scale at this establishment, and for selling it to retailers.

Birmingham and one or two other towns have preceded the metropolis in the system of making bread on a large scale, in a few bread-factories, and supplying retail shopkeepers. There are two joint-stock companies in Birmingham for this purpose, both of which realise fair dividends for the capital invested.

In Carlisle, besides the manufacture of bread and biscuits in certain large and well-organised establishments, there is a custom of making wholesome second-class bread by an admixture of maize or Indian corn with wheat in some households. The following instructions for this purpose have been given: Take seven pounds of Indian corn flour, and pour upon it four quarts of boiling water, stirring all the time. Let it stand till the temperature becomes lukewarm, and then mix it with seven pounds of fine wheaten flour, to which a quarter of a pound of salt has been previously added. Make a depression on the surface of this mixture, and pour into it two quarts of yeast, which should be thickened to the consistence of cream with some of the flour. Let all remain quiet during the night, and on the following morning knead the mass, and allow it to stand for three hours. Then divide the dough into loaves, and bake them in tins, in which they should be allowed to stand for half an hour before baking. From these materials about thirty-two pounds of nutritive bread can be obtained.

Referring to the article YEAST, for an account of the chief modes of obtaining or producing that (hitherto considered) indispensable ingredient in bread, we may here mention an item of statistics which shows how large must now be the consumption, in the United Kingdom, of that apparently trifling article. In the three years ending with 1858, the average quantity of dry yeast imported amounted to 77,000 cwt. annually.

There is at present (1859) a praiseworthy attempt being made to bring about a change in the condition of the journeymen bakers employed in and near the metropolis. It has long been treated as a necessity that bakers should work at night, in order that families might have a supply of newly-baked loaves and rolls by the ordinary breakfast-time; and the arrangements between the employers and the employed bear immediate relation to this system. It begins now, however, to be disputed whether this necessity exists. The introduction of some of the recently-patented improvements, and a re-partition of the hours of working, would (it is contended by many well-informed persons) enable the working bakers to sleep at night, a regular number of hours, and out of the pernicious atmosphere of the bakehouse. An inquiry made by Dr. Guy, a few years ago, revealed a deplorable state of things, in reference to the daily life of the persons thus employed. A considerable impression was made on the public mind by these and similar revelations; and under the influence of this impression, the master-bakers of Edinburgh have one by one abandoned the system of night-work, and afforded to their journeymen the opportunity of obtaining rest at the same reasonable hours as other men. It is stated that the masters do not incur any commercial loss by the change, while the relations between them and their men are much more cordial and satisfactory than before. A communication to this effect has been transmitted from the master-bakers of Edinburgh to those of London. Glasgow and Belfast have also, to a great extent, adopted the new system; the inhabitants of those three cities appear to be satisfied with a bread-supply so managed that twelve hours journeymen's labour per day, from five o'clock in the morning till five in the evening, shall suffice; and there seems no good reason why the same plan, if judi-

ciously managed, or one nearly similar to it, should not be adopted in the metropolis.

BREAD, BEES, AND ALE, ASSIZE OF. [ASSIZE.]

BREAKWATER, a construction formed in the sea, or in any large body of water, for the purpose of destroying the action of the waves, and of thus securing the tranquillity of a roadstead. A breakwater, in fact, as the word has been of late years applied, differs from a pier or a jetty, insomuch as it serves to protect a roadstead, and is formed in deep water, without any connexion with the shore; whereas piers or jetties only shelter closed basins, and are joined to the main land.

The engineers of antiquity executed, during the prosperous days of the Roman empire, some remarkable works of the nature of breakwaters, as we understand the term; and the entrances to the ports of Ostia and of Antium were protected by artificial islands, formed so as to break the force of the waves driving against them. It was not however until the latter end of the 18th century that modern engineers undertook any great work of this description. At that period the French government commenced the execution of the breakwater at Cherbourg; and subsequently similar operations have been carried on at Plymouth, Cette, the mouth of the Delaware, in Lake Erie at Buffalo, and at Portland, Dorsetshire. As the construction of the breakwater at Cherbourg was attended with the greatest difficulties, and has been studied more carefully than any of the analogous works, it will be noticed a little more in detail.

The breakwater of Cherbourg consists, at the present day, of a mass of rubble stone, cast into the water and allowed to assume its own natural outline; it is 12,356 English feet long, and in plan it presents the form of a species of chevron, whose arms are of unequal length, and which presents towards the open sea an obtuse angle at the summit, of 169°. The depth of water in this part of the roads is 61 feet at low water of average spring tides, and the width of the base is about 298 English feet; its transverse section may be described generally as follows: From the base to the level of about 22 feet below high-water line of spring tides, the slope on the land side is in the ratio of 1 in base to 1 in height (1 to 1); the top of the mass has then a much more gentle inclination, for in a width of 19½ feet its inner summit attains the height of 15¾ feet below the said high-water line, or the slope is in fact, nearly 3 to 1. At this level the slope stops against a wall, almost vertical, which rises to 7 feet above the high-water, or datum line, and is crowned by a platform of about 21 feet in width, beyond which there is a solid granite parapet 8 feet wide and 5 feet high towards the sea. The outer line of this parapet is itself in continuation with the sea face of the wall, forming in fact the crown of the breakwater; and the wall is built of course granite ashlar, laid with the greatest care, and composed of the best materials, upon a general bed of hydraulic concrete 5 feet thick, extending over the loose rubble walling, at a level of 29 feet below datum. Beyond the edge of the masonry which protects the foot of the vertical wall, the slope assumed by the loose rubble, towards the open sea, is 1 in 10, until it reaches the depth of about 47 feet below datum; and from that level to the base the sea slope is about in the ratio of 1½ to 1. It was found that the small stones at the foot of the vertical wall were very much disturbed by the movement of the waves; but this inconvenience has been of late materially obviated by covering the fore slope of the breakwater with huge artificial blocks of rubble masonry, set in Portland cement. The area sheltered by this gigantic structure is not less than 1926 acres nearly; but only about one-third of this area has a depth of 26 feet at low water of spring tides. At the bottom of the roads thus artificially protected are the military and the commercial ports of Cherbourg.

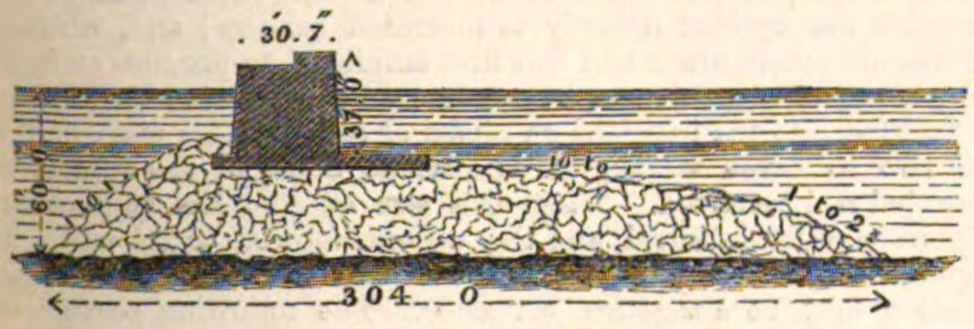


Fig. 1.—Cherbourg.

The works for the construction of the Cherbourg breakwater were commenced about 1783, by De Cessart, under the government of Louis XVI.; and they have been carried on with various success and upon various plans, by all the governments of France, until in the year 1853 the whole of the substructure was completed to such an extent as to allow the commencement of the fortifications proposed to be erected. It is estimated that the total cost up to 1853 was not less than 2,682,491*l.* sterling.

Plymouth breakwater is formed in a bay which is naturally more sheltered than the comparatively speaking open roadstead of Cherbourg; and its construction was favoured by the existence of some natural reefs upon the direction proposed to be adopted: nevertheless there was great boldness in its design, and the rapidity of its execution contrasts markedly with the slow progress of its great prototype. The plan of the Plymouth breakwater consists of a principal rectilineal mass with two return arms, forming with the centre body obtuse

angles towards the sea of about 135°; the length of the centre body is about 1000 yards, and that of each of the arms about 350 yards; or in other words, the length of this work is only 5100 feet, whilst that of the Cherbourg breakwater is 12,356 feet. A surface of about 1120 acres is protected by the work executed at Plymouth.

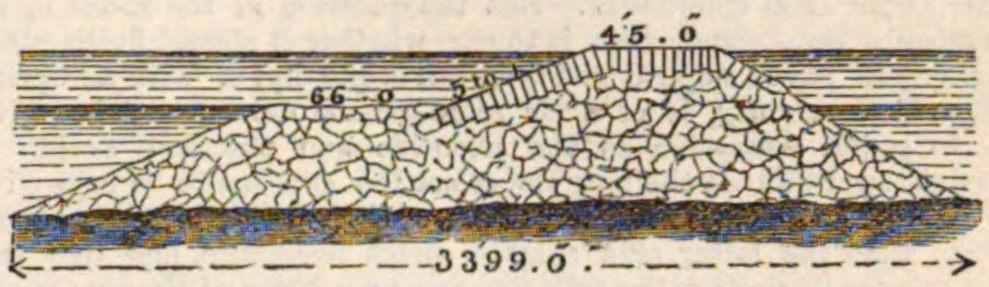


Fig. 2.—Plymouth.

Originally it was intended to make the top of the breakwater only 11 yards wide, and the bottom 55 yards wide; but during the execution of the work, those dimensions were respectively increased to 15 yards and 133 yards. At the level of low water of spring tides, a set-off of about 22 yards in width is formed; and the sea slope from this point upwards is paved with very large stones, bedded in Roman cement; and the paving has been continued below low water line by means of the diving-bell. The height of the crown of the Plymouth breakwater is only 2 feet above the level of the high spring tides; whilst the height of the parapet of the vertical wall of the *digue* at Cherbourg is at least 12 feet above this line. The questions connected with the outlines of the respective works in the zones exposed to the action of storms will be noticed hereafter.

The Delaware and the Cette breakwaters do not exemplify any particular principle, nor do they illustrate any peculiar mode of construction, so that it may suffice to say that the former is about 1000 yards long, measuring upon the line of high water. Its slope towards the harbour is about 1 to 1; and the top, which finishes at about 5 feet 4 inches above the level of the highest spring tides, is about 30 feet wide. The outer slope is carried down, with an inclination of 3 base to 1 height, to a depth of about 19 feet below low water of spring tides,

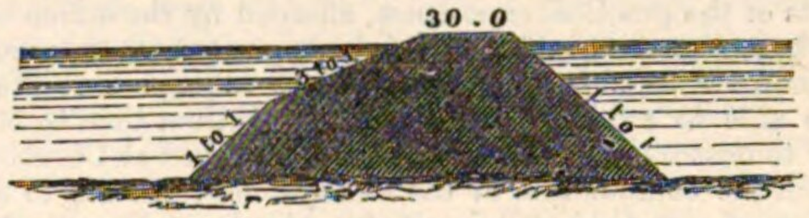


Fig. 3.—Delaware.

Fig. 4.—Cette.

and, from thence to the bottom, the inclination is only as 1 to 1. The breakwater at Cette is principally remarkable on account of the great height to which the mass of masonry is carried above the high-water line; this is not less than 19 feet; and perhaps also the cubical contents of the transverse section may be cited as being worthy of remark. The total depth of water is only 24 feet in this part of the Mediterranean, but the width of the foot of the Cette breakwater is not less than 254 feet; its total length is about 514 yards, and the outline on plan is convex towards the open sea. The breakwater at Buffalo, in the state of New York and in Lake Erie, is constructed with nearly as much solidity as analagous structures in the ocean. It is, however,

Fig. 5.—Buffalo.

made with a vertical face towards the shore, and at about 5 feet above the water-line there is a platform 18 feet wide; upon this a wall is erected 5 feet high and 15 feet wide, from the outer edge of which the rubble masonry is carried with a slope of 3 to 1 to the shore of the lake.

The Portland breakwater is being constructed upon precisely the same principles as that of Plymouth; and it is therefore only remarkable on account of the mechanical contrivances adopted in the course of its execution.

There have been submitted to the public, of late years, a great number of schemes for forming floating breakwaters, wave screens, or for employing some more economical system than that of creating, as it were, artificial islands. But the marked failures of these ingenious contrivances have been so notorious, that it would be unnecessary here to discuss any of them. The attention of engineers charged with the execution of such works is, in fact, now exclusively directed to the

means of transporting the materials to the place of deposit, rapidly and economically; and to the various modes of terminating the exposed surfaces. Of course local circumstances will affect the first of these branches of inquiry; for the conditions which have allowed the use of locomotive power in the case of Portland, were totally wanting at either Cette, or at Cherbourg. But the question of the mode of terminating a breakwater, that is to say, whether it should finish with a long, gentle, paved slope as at Plymouth originally, or with an upright wall as at Cherbourg, is of a far more general nature, and has given rise to much discussion in the scientific and practical world. It certainly appears that the long slopes are less exposed to be injured by the direct action of the sea than are the upright walls; but it is equally certain that the latter offer a more direct resistance, and that they more effectually destroy the agitation and undulation of the sea; so that even if they should be rather more costly in their erection and maintainance, they are at the same time more effectual. In the case of the Plymouth breakwater, for instance, the waves occasionally have broken over the top, and have produced a considerable agitation in the inner roads; whilst at Cherbourg all their effect is destroyed by the wall. At Cherbourg, however, the descending motion of the return wave is materially interfered with, in consequence of the peculiar section presented by the wall; for the vertical wall at the top of the long slope transforms the descending into a horizontal motion, whose action is highly dangerous to the stability of the wall itself. It is also found that large blocks of stone are moved by the force of the waves from the fore slope of the Cherbourg breakwater, and that they are driven with great force against the outer face of the vertical wall; whilst the waves upon the Plymouth breakwater, from the fact of their not meeting any direct resistance, break upon its fore slope in precisely the same manner they would do upon a natural shore, and with a considerably reduced violence. It is true that in consequence of the particular section given to this Plymouth breakwater, the waves acquire an increased horizontal motion; but as the top is made as smooth as possible, there are no salient points able to attract the destructive action of the sea. Notwithstanding all the precautions taken at Plymouth, however, the repairs of that work are of a very costly, and unfortunately of a permanently recurring character; and the results of the practical experience, afforded by the action of storms upon works of this description, certainly at present must be considered to have shown that it is preferable at once to oppose to the waves a resistance able to annihilate their onward motion, than to endeavour gradually to destroy it. The worst effects observed at Cherbourg have arisen from the combination of the two systems; that is to say, from the erection of a vertical wall on the top of a long slope; and it is on this account that it has been necessary to adopt the extraordinary precautions lately taken for the purpose of defending the foot of the former. Practically it may be considered to be demonstrated that the most effective, because most economical and permanent, method of destroying the violent action of storm-waves, is to oppose to them an upright wall of such materials, and so constructed, as to offer a resistance considerably in excess of their effort. This effort was calculated by M. Duparc, one of the most distinguished engineers employed on the Cherbourg breakwater, at from 6100 to 8100 lbs. per yard superficial; and he therefore made the mass of his wall such as to offer a resistance equal to about 32,000 lbs. per yard superficial, to an effort tending to overthrow it; and to about 24,000 lbs. per yard superficial to an effort tending to make it move horizontally. The effort of the sea upon this structure has been found to be considerably in excess of the above calculation; but hitherto its powers of resistance have sufficed. The form and dimensions given to the enormous jetties of Dover, it may be here observed, seem to be as satisfactory as those of any analogous work in existence.

The reader is referred, for further information, to the description of the 'Travaux d'Achevement de la Digue de Cherbourg,' par M. Bonnin, 4to. Paris, 1857; Rennie's 'Treatise on the Formation of Harbours,' 2 vols. fol. Lond. 1852; the Parliamentary Reports upon the Harbours of Refuge, &c.

BREANE ($C_{40}H_{32}O_2$?). One of the constituents of Icica resin. It crystallises in radiated, colourless, and tasteless needles, which are quite neutral, insoluble in water and alkalies, almost insoluble in cold alcohol, but soluble in ether. It is fusible by heat, but cannot be distilled without decomposition.

BREAST, DISEASES OF. The mammary gland, especially in the female, is liable to various diseases, requiring the attention of the medical man.

Irritable Mamma. In both married and unmarried females the breast is liable to irritation from sympathy with other parts of the system. In these cases there is often great pain and uneasiness in the breast, and the whole system suffers more or less. There is no inflammation, and no swelling or external alteration of the mamma. The pain is sometimes intermittent or periodic, similar to neuralgia. When the general health is affected this must be attended to. Opium and hemlock may be employed internally, and nitrate of silver, belladonna, and aconite, have been recommended externally.

Mammitis. Inflammation, acute and chronic, of the substance of the mamma is not an unfrequent disease. It comes on from exposure to cold or a blow, or during the period of lactation. The pain is intense; the breasts are swollen, and tender to the touch. From the first there is a tendency to suppuration. The secretion of milk is perverted and arrested. In the treatment leeches and warm fomentations and poultices should be applied to the breast. The bowels should be kept open, and the fever subdued. When matter forms it should be early evacuated. A chronic inflammation is sometimes observed. When this is the case stimulant applications to the breast will be found useful. Where this is attended with abscess it should be opened, so as to give free exit to the pus, and pressure applied.

Tumours of the Breast. The breast is subject to various kinds of partial and general enlargement. The "chronic mammary tumour" of Sir Astley Cooper consists of a partial hypertrophy of the gland. Enlargement of the whole gland also frequently takes place. These enlargements may be got rid of by pressure and treatment of the general health. The lactiferous ducts are sometimes blocked up, so as to produce distension, and an enlargement called *lacteal tumour*. Puncturing the enlarged tube and keeping it open will cure this form of tumour. The breast is also liable to fatty tumours, fibrous tumours, cystic sarcoma, hydatids, and malignant tumours. In many of these cases it becomes necessary to remove the breast. This is done in the following manner: "The patient having been placed recumbent, and duly anæsthetised, the arm on the affected side is raised and held by an assistant, so as to stretch the pectoralis major and facilitate incision. The knife is entered in the axillary aspect of the tumour in a line with the mammilla, and is moved in a semi-elliptical direction towards the opposite point; a similar proceeding is adopted—above or below, as the case may be—to complete the ellipse, and the size of this space necessarily varies according to the extent to which the integument seems to be involved, and according to the natural laxity of the parts. It is a fault to take away an undue amount of sound textures, so that difficulty is experienced in effecting and maintaining apposition of the wound; but it is a worse error to leave tainted parts, whereby reproduction of the disease cannot fail speedily to ensue. It is well to make the lower incision first, otherwise its course and position are apt to be uncertain under the irrigation of blood. Then on each aspect the knife is sloped through the subcutaneous part; and regular dissection is proceeded with from the axilla downwards, dividing the principal vessels and nerves at once, and so rendering the subsequent steps of the operation comparatively bloodless and free from pain. The diseased mass, with its border of comparatively sound tissue, in the case of malignant tumour, having been removed, is carefully examined on every aspect by both sight and touch; and, if need be, the knife is re-applied where thorough removal is not assuredly apparent. The vessels having been secured, the wound is brought together and treated in the ordinary way."

Much has been recently said of the removal of malignant tumours, especially of the breast, by means of escharotics. It is always difficult to decide exactly as to whether a tumour is malignant; and from all that has hitherto been made known of these formations, it would appear that, if they are cured by general or local treatment, the inference is that they were not malignant. With regard to general treatment, the evidence is very decisive that we possess no internal remedy that has any known influence over the progress of those tumours which are truly malignant. A recent American writer has professed to remove cancerous ulcers by a general and local treatment, which has been witnessed and reported on in this country. The cases referred to were treated at the Middlesex Hospital. The general treatment consisted in the administration of iodide of arsenic and the *Sanguinaria Canadensis*. The local treatment consisted in the application of the Sanguinaria and chloride of zinc. The method employed was to make a decoction of the sanguinaria, and, with an equal quantity of the chloride of zinc, to make the whole into a paste with common flour. This paste was applied directly to ulcerated cancers; and, where the skin was unbroken, nitric acid was first employed to produce an eschar. After this process incisions were made into the tumour, and the paste was inserted into the incisions on pieces of calico. This was continued from two to seven weeks, till the whole depth of the tumour was penetrated and removed. When this was effected the application of the paste was discontinued, and the wound allowed to get well. The Sanguinaria seems to exert no effect in this treatment, and its consideration may be altogether set aside. The following passage concludes the report of the surgical staff of the Middlesex Hospital on this mode of treating malignant tumours:—

"The last peculiarity of this treatment is the practice of incisions; and we are of opinion that this is its only but its very great merit. The Sanguinaria is inert; the chloride of zinc paste was known before; but the incisions constitute a new feature in the treatment of cancerous tumours for which we find no parallel in the writings of the past, or in the practice of present surgeons. Cancer in its constitutional nature remains as ruthless and as unassailable as ever."

BREAST-PLATE. [ARMOUR.]

BREAST-WORK is a term applied to any hastily constructed field-work, being sometimes not sufficiently high to necessitate a banquette. When the work has its surfaces carefully formed, and revetted or covered with sods, particularly when it is elevated on the rampart of a fortress, or constitutes a considerable field-fort, it is always denominated a parapet—the word *breast-work* being chiefly applied to a rudely formed mass of earth thrown up to cover the troops stationed on any exposed part of a field of battle, or doing duty as an outpost of the

army; or to the *gabionnade*, that is, the row of gabions placed on end and filled with earth, which the sappers construct for the protection of the troops in the trenches, or on the breach which is made in a rampart. A breast-work, however, differs from an epaulement, which is also a mass of earth or other material raised to cover troops or artillery when in situations exposed to the fire of the enemy, in being constructed to fire from.

The intrenchments with which the Greeks and Romans protected the ground occupied by their armies were breast-works, which in wooded countries frequently consisted merely of felled trees; and in other circumstances were formed of earth protected by palisades, or by the interwoven branches of trees planted on the top of the bank of earth. The same denomination might be applied to the continuous lines which were formerly raised for the protection of armies; but as these are not now recommended by engineers, and as instead of them a number of separate redoubts are usually formed at intervals from each other to contain artillery, the word breast-work is little used, the protecting masses of earth generally receiving the name which is given to those which crown the ramparts of a permanent fortification.

BREATH FIGURES. If we write with a blunt wooden point upon a clean surface of glass or other polished material, and then breathe upon it, the characters will become visible: or if we first breathe upon the glass, and then trace some characters with a blunt point in the midst of the breath, the characters can be brought out again by breathing on the surface. Hence the Germans call the figures which are produced by the breath, *Hauchfiguren;* while the French philosophers term them *figures roriques*, or *roric* figures, from the Latin for "dew," *ros*, gen. *roris*.

These figures, which may be produced in a variety of ways, first excited attention in the year 1842, when Moser of Königsberg announced to Humboldt the remarkable proposition that "if any two bodies be brought sufficiently near together, and face to face, one of them impresses its image on the other." Thus, if a coin be left for some time upon a polished metal plate, the plate will retain an impression of the coin, which may be made visible by exposure to the vapour of water, mercury, iodine, &c. So, also, if a polished plate of silver, or of copper, be covered by, but not in contact with, a blackened glass plate, with some characters scratched on it through the opaque black, and so exposed for some days to the sunshine, the metal plate will be impressed with the characters, which will make themselves visible by exposure to vapour. Experiments of this kind may be varied to any extent; and no sooner did Moser call attention to them, than other persons were ready with similar examples. Thus, Rauch, the sculptor, stated that the glass used to protect a print after Raphael, although not in contact with it, had received an impression of the print on its inner surface. It was found on inquiry that this fact was well known to persons accustomed to frame prints.* Breguet, the celebrated Parisian watchmaker, stated a fact that had long been known in his workshop; namely, that the inscription and letters on the back of the inner cases of his watches were found repeated on the inside of the outer cases, although the two surfaces were not in contact. It was also noticed by engineers, &c., that the parts of machines in contact or near together easily and quickly impress themselves upon each other.

It was also found that very perfect impressions of objects could be produced by means of electricity. Thus, if a coin be placed upon a glass plate which is supported by a metal one, and a stream of sparks from the knob of the prime conductor be thrown upon the coin, about a hundred turns of the machine will suffice to impress the coin very perfectly upon the glass. On throwing off the coin, nothing is visible until the breath be projected upon the plate, when the image and superscription, the milling, and other minute details of the coin instantly appear. In producing these impressions on metal, it is necessary to separate the coin from the metal by means of a thin plate of mica, or of glass, or oiled paper. The impression is produced after about fifteen or twenty turns of the machine, but by continuing the action on a polished silver plate a permanent impression has been made as distinctly as if it had been etched by aqua fortis. As many as one thousand turns of the machine are required for this effect, and it would be reasonable to suppose that nitric acid was actually formed, but Karsten, who first obtained electrical breath figures, was not able to detect the presence of any.

Moser explained the production of his figures, which could be formed in total darkness as well as in light, by referring them to the action of the most refrangible dark rays of the spectrum, considering that all

* While reading this proof we have received, from Professor George Wilson, of Edinburgh, the following remarkable case: "In connexion with electric images, I received yesterday two photographs, the peculiarities of which I shall try to explain. The wax-paper negative of a ship was laid in the usual way for printing, on a sheet of prepared paper, and below the latter intended to receive the positive copy, a sheet of ordinary letter post was laid to act as a packing in the printing-frame. The positive was duly taken, fixed, and laid aside. Some time after *another* negative, namely, of a sloop, was arranged as before, with a piece of *positive paper* next it, and for package, the *same* sheet of letter post as before. When the positive was removed, it had the *sloop* on one side, and the *ship* in addition on the other. In some strange way the letter post had received a latent image, I suppose, of its first neighbour, the *ship*, and transferred this to the back of its second neighbour the *sloop!* Fixing has dimmed the sharpness, but there they both are."

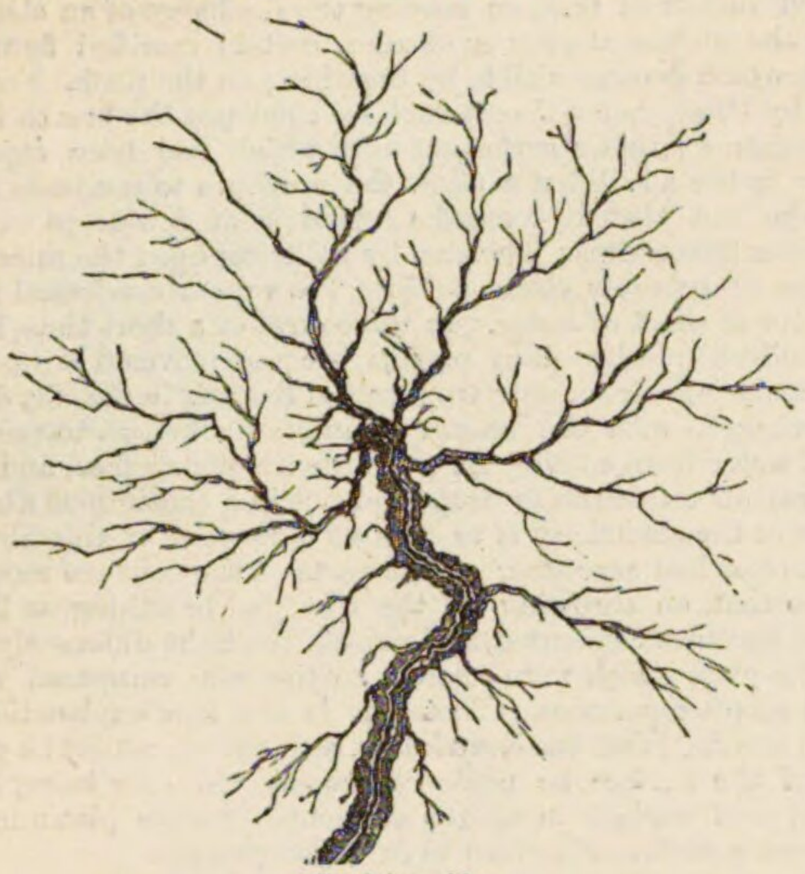
bodies radiate light even in the dark. Karsten's figures received a more satisfactory explanation from the experiments of Riess, who many years before had remarked that, on sending the discharge of an electric battery over the surface of glass or of mica, certain ramified figures were produced, which became visible by breathing on the plate. Now, it was observed by Riess, that different surfaces condense the breath in a very different manner; that a surface of mica which had been exposed for some time to the air, did not allow the moisture to condense in a continuous film, but that it formed a congeries of dew-drops with many breaks and interruptions; whereas, by splitting open the mica so as to obtain one of nature's clean surfaces, the vapour condensed in a continuous film or sheet of water. In the course of a short time, however, the new and chemically clean surface becomes covered with a film of matter chiefly organic, arising from motes floating in the air, dust, and moisture charged with the breath of animals sufficient to prevent the vapour of water from coming in contact with the surface, and explaining why vapour condenses in drops and not in a continuous film. Now, the action of the electricity is to burn off a portion of this film, which it does more or less according as the parts of the coin are more or less salient; so that, on throwing off the coin and breathing on the plate, the breath becomes condensed, and reflects the light differently in those parts of the plate which were nearest to the coin compared with the other and remoter portions. That this is the true explanation is evident from the fact, that the electrical breath figures cannot be produced on glass if the surface be made chemically clean by being boiled in nitric acid and washed in dilute ammonia; nor on platinum if that metal be made sufficiently clean to fire hydrogen gas.

This simple explanation is not however sufficient to account for all the varieties of roric figures. There must also be some molecular change induced in the plate itself, which, though quite invisible to the eye, nevertheless disposes the surface so as to make it catch the breath differently. Karsten states that eight or ten thin plates of glass superposed, will all receive the impression of a coin placed on the top plate and electrified; the impressions become fainter and fainter in descending, and at a certain depth disappear. This seems to be a case of molecular action in the lower plates not to be explained by the burning off of a portion of the film in the upper one. So, also, if we cover a polished surface, such as granite, with a perforated pattern or trellis-work, and expose it to the sun for half an hour, the vapour of water, or mercury, &c., will afterwards, when the perforated pattern is removed, make out the pattern with perfect distinctness. This molecular action is assisted by heat, as in the last experiment, and still more strikingly by placing a sovereign on a glass plate on the warm mantel-shelf, and leaving it there for half an hour. On throwing off the sovereign and exposing the glass to the vapour of mercury, the details of the coin are beautifully made out. In this case, the warmth streaming up through the glass is intercepted by the metal and reflected back again upon itself, and that differently by different parts of the coin, whereby a new arrangement of molecules is produced at the surface, and the vapour of mercury is caught and held with corresponding differences in different parts of the surface thus acted on, so that the light reflected by the vapour informs the eye of these differences, and thus makes out the image of the coin. We should be disposed to refer the impression to the action of radiant heat when the coin is not in contact with the plate, but suspended at a short distance over it. It requires in such case a longer time to produce the impression, but it is nevertheless made.

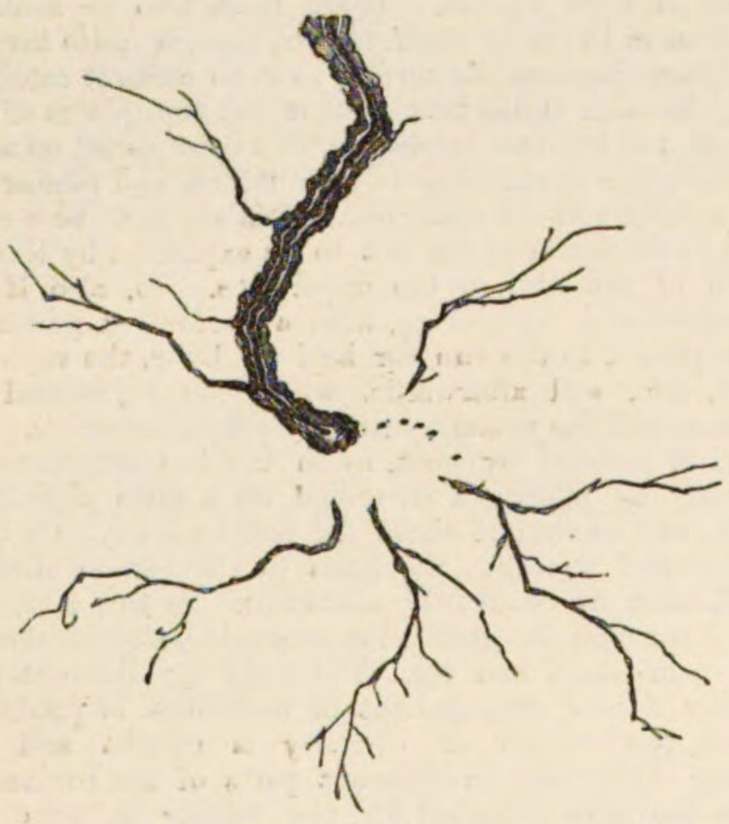
De la Rive and others, who contend for the electrical origin of roric figures, imagine that the surfaces, though not in contact, have electricity developed upon one of them at least, by the action of a moist atmosphere. It is stated also that the metals must be of different kinds, as in Mr. Hunt's experiment, in which a sovereign, a shilling, and a penny were placed on a copper plate, when the two former gave excellent images, and the penny a very slight one. It is stated that roric images cannot be produced on plates of gold and of platinum, nor on a surface that does not oxidise; also that in very pure water deprived of air, and also *in vacuo*, these images are formed either not at all, or but slightly. Many of these statements are the result of preconceived theory, in which there is an anxiety to explain the production of all roric figures by electricity; whereas, as there are many modes of producing these figures, so there are, in the wide diversity of nature's operations, several methods of explaining them.

Some remarkable roric figures may be produced on the surface of glass by any one who is in possession of a small electrical machine, a Leyden jar, and a discharging rod. Plates of crown glass about four inches square answer the purpose very well; they should be washed in soap and water, and carefully dried. The jar should be fully charged; and on discharging it, with a plate of glass interposed, the spark will pass to one of the edges of the plate, and turning round will proceed up the glass on the other side to the knob of the discharging rod. In this way the electricity traces a figure on both sides of the glass, and it becomes visible by breathing on the surface. The figure, on the side of the glass presented to the jar, which we may call the *positive* side, is much more developed than on the other, or *negative* side. The following engraving is a specimen of the figures thus produced. The various ramifications do not proceed *from* the trunk or course of the discharge, but the trunk proceeds from them. In fact, these minute and delicate branches are *feelers*, sent out to determine the line of

least resistance, and they mark themselves upon the glass before the principal discharge takes place. That such is the case is evident from



Positive side.



Negative side.

the fact, that if the plate be too large, or too thick, or the jar not fully charged, or the electricity deficient in tension, no disruptive discharge takes place, but the plate becomes covered with these ramifications, while the charge still remains in the jar. A corresponding action takes place in nature. Just before a ship has been struck by lightning, the people on board sometimes speak of the well-known electrical sensation as if a cobweb were being drawn over the face; they also hear a hissing roaring noise, and perceive brushes of light. These sensations are also sometimes experienced when, from some cause or other, no discharge takes place. This class of roric figures admirably illustrates the phenomena of lightning, or that form of discharge known as *ribbon* or *chain* lightning. It descends from the thunder-cloud to the earth in the same jagged trembling line as here represented, sometimes dividing into two or three main branches, and these bi-furcations or tri-furcations are often admirably produced on the glass plates. The writer of this article has made several attempts to render these figures permanently visible on the glass, but he has not yet succeeded in doing so. The vapour of mercury, &c., brings out only the principal lines of discharge; while a coating of collodion, candle-smoke, &c., does not receive the details of the impression. The discharge appears to produce some permanent change on the surface of the glass, so that while the breath is condensed on the portions unacted on, it does not condense on the parts occupied by the figure. When once the figure has been formed, it is difficult to get rid of it, the ordinary methods of washing and rubbing failing to do so effectually. There are many points connected with these figures which are still open to inquiry. It is curious also to notice the various modes in which the breath condenses on the plates, according to the temperature of the air and the amount of humidity or dryness, the tension of the electricity, and the state of health of the experimentalist. During the warm humid weather which occurred on certain days at the end of May and the beginning of June, 1859, it was almost impossible to produce these figures. Then again in breathing on the plates a quantity of organic matter is deposited, which varies with the kind of food, the time that it has been taken,

and the state of health of the individual. The breath moreover is differently deposited when projected by different individuals. The state of the breath is known to have a considerable influence in photography, and it has been noticed in other arts. In an old French treatise on Enamel Painting (' Dict. des Arts et Métiers,' Lyon, 1801), the artist is cautioned not to let any one approach his work who has been eating garlic or taking mercurial medicines.

BREATHING. [Respiration.]

BREAST-WHEEL. [Hydraulics.]

BREEDING is the art of multiplying the domestic animals rapidly, and at the same time improving their qualities.

Any breed of animals will perpetuate itself, if a sufficiency of proper food be provided; and the varieties found in a wild state must depend in some degree on the climate and the products of the country in which they are found. Care and domestication also produce varieties, which are much more useful or profitable than the wild breeds; and in the selection of the best individuals to propagate a useful race, and in the rearing of the young, consists the art of the breeder.

Without entering into particulars, which vary with every species of animal, and with the different varieties of the same species, we shall lay down certain principles which experience has proved to be correct, and which being attended to will greatly promote the improvement of all the different animals usually bred for the use of man, whether for his sustenance or for his pleasure. The first thing which is to be kept in view is the chief purpose for which the animal is reared, whether for labour and to assist human strength, or for speed, to convey us rapidly from one place to another; whether merely for a supply of animal food, or to produce the raw materials of manufacture. In each of these cases distinct qualities are required; and it is seldom that two of these objects can be combined in the greatest perfection.

Having then determined the purpose for which any species of domestic animal is designed, every quality must be attended to which furthers this view; and, except under very peculiar circumstances, the animals intended to keep up the stock by their produce must be chosen with those qualities in the greatest perfection which are essential to the end. In all animals a perfect conformation of the bodily frame is essential to the due performance of the vital functions. The skeleton of the animal should therefore be as perfect as possible. The capacity of the chest, and the healthy nature of the lungs, are points which must never be overlooked, whatever may be the purpose for which the animal is bred; for although a defect may in some measure be counteracted by a judicious choice of the individual coupled with the defective animal, it is only where there is no alternative or choice that any defect in the bodily frame of an animal kept for breeding should be overlooked. In spite of every care, the defect will appear in the offspring; sometimes not till after several generations. If it were possible to find individuals without fault or defect, no price would be too great for them; and for those that have been carefully selected for several generations, it is real economy to give a very liberal price. In horses bred for racing or for the chase, experience has fully proved the truth of this rule; and no one who pretends to breed race-horses would breed from a mare which had a natural defect, or a horse whose whole pedigree was not free from fault. For mere swiftness the shape of the animal, whether horse or greyhound, must combine strength with great activity. The chest must be deep, the lungs free, and the digestive organs sound but small, to add as little weight to the body as is consistent with the healthy functions of nature. The legs should be long and slender, and the bones compact and strong; but the principal thing to be attended to is the courage, and no quality is so hereditary. A horse or hound of a good breed, if in health, will die of exertion sooner than give up the chase. Any defect in courage in an animal intended for great occasional exertion, renders him unfit to be selected to continue an improved breed; and whatever may be his pedigree he has degenerated.

With respect to animals whose strength and endurance are their most desirable qualities, a greater compactness of form is required, a greater capacity of the digestive organs, and, according to the climate to which they may be exposed, a more suitable covering. Whether it be to ward off cold or great heat, a thick covering of hair is equally serviceable in both cases. Hardiness of constitution is hereditary, like other qualities; and the manner in which the young are reared tends greatly to confirm or diminish this. An animal of which the breed originally came from a warm climate, like a tender exotic plant, wants artificial warmth for the healthy growth of its limbs; while the indigenous and more hardy breeds may be left exposed to the elements. An abundance of wholesome food and pure water is essential to the healthy state of every animal, as well as exercise proportioned to its strength. These are circumstances which it is obvious must be carefully attended to. There are others, the result of long experience, which are equally necessary to be known, but which are not so obvious. These vary according to the species and variety of the animals bred; and it is seldom that the same breeder is equally successful in rearing different species of animals.

In the animals selected to breed from there are *points*, as they are called, which are peculiar conformations, some of which are connected with the natural formation of the skeleton, and others appear to be the result of an association derived from the known qualities of certain

individuals, and of which no very good physiological account can be given. That high withers and a freely-moving shoulder-blade in a horse are connected with his speed is readily perceived, and that the length of the muscles of the quarter, and the manner of their insertion, should affect his power is equally evident; but it is not so apparent that the manner in which the ears are placed on the head, the shape of the nose or jaw, and the insertion of the tail higher or lower, has an important effect on the value of the animal, independently of any arbitrary idea of beauty. A breeder however who should not attend to these circumstanees in the animals chosen to perpetuate the breed, would find to his cost that it is more than mere taste which has determined these points. It is the result of observation and experience that certain breeds are invariably distinguished by certain peculiarities, and that these are almost as invariably connected with good qualities, apparently quite independent of the parts on which these points appear.

There is an indication of the disposition of an animal in the eye, in the shape of the head, and in the manner in which it is carried, which seldom deceives an experienced judge. He will not risk introducing a vicious or sulky disposition into his breed, which might counterbalance all the good qualities the animal might possess, and introduce a greater hereditary fault than any imperfection of form.

But nothing is so deceitful as the prejudices which exist with respect to peculiarities and colours. In some countries no ox or cow would be thought good of its kind that was not red or brown without spots; in others, a certain portion of white is essential. In Suffolk, no cart-horse is prized which is not chestnut; in Northamptonshire, he must be black; in Yorkshire, brown or bay. This is owing to the common colour of the breed most esteemed in each country. In Belgium, whence the Suffolk breed originally came, but which has degenerated in its native country, a chestnut horse, with a white mane and tail, as well as a red cow, are despised. Here the reason of the prejudice is the association of the colour with some defect, and those who breed for profit by sale must be ruled by the taste of their customers. The rational mode of proceeding is, to be well acquainted with the anatomy of the kind of animal which we make the subject of our attention; to learn by experience what are the peculiar qualities of the different breeds, distinguished by any particular feature, and whether these qualities have any apparent connection with the peculiarity in make or colour. We may then be guided by the knowledge thus acquired in our choice of individuals, to perpetuate the breed, and not only preserve the useful qualities which they already possess, but gradually improve them. No greater mistake can be committed than that of making what are called violent crosses, such as coupling a very spirited male with a sluggish female, an animal with large bones with one of very slender make, a long-limbed animal with a compact one. By such crosses the first produce has often appeared much improved; but nature is not to be forced, and if the breed is continued, innumerable deformities and defects are certain to follow. The safe way is to choose the animals as nearly alike in their general qualities as possible, taking care that where there is a defect in one it exist not in the other, which would infallibly perpetuate it. A defect can never be remedied by means of another of an opposite kind, but, by great attention, it may be diminished gradually, and at last disappear entirely. This refers however to *defects*, not to peculiar qualities. Cows, for example, may produce either milk or fat in abundance from similar food; and a species of cow, which secretes too much fat, so as to be deficient in the milk necessary to rear the calf, may be improved by selecting individuals which give more milk, and by crossing the breed with these; but we must be careful not to choose individuals which differ much in shape from the breed to be improved. A cross between a Herefordshire cow and an Alderney bull might possibly produce a good cow, but the breed of this cow would probably be of inferior quality, whether for fattening or for the dairy, and nothing but ill-formed cows, deficient in milk, and slow-feeding oxen, are likely to result from it. Every attempt to unite opposite qualities is generally attended with a bad result. If a breed has too great an aptitude to fatten, so as to endanger the fecundity of the mother or the health of the offspring, the only remedy is to diminish the food; and if, on the other hand, a difficulty is found in fattening cows which are of a peculiarly good breed for the dairy, such as the Alderney cows and other small breeds, the loss on the old cow sold half fat will have been amply repaid by the milk she has given; and the bull-calves which are not wanted to rear for bulls, if they are not profitable to fatten as oxen, must be fatted off young and sold for veal. But it is not a necessary consequence of an abundant produce of milk, that the cow, when dry, will not fatten readily; although a great propensity to fatten renders the breed less fit for the dairy. The Ayrshire, which are good milkers, fatten well when dry, and the oxen of that breed are as kind feeders as any.

Many breeders have an idea that coupling animals which are nearly allied in blood produces a weak race; others consider it as a prejudice, and among those who held the latter opinion was the famous breeder Bakewell. Without deciding this point, we should recommend avoiding too near a relationship, provided individuals equally perfect can be found of the same breed more distantly related. Every individual has some peculiar defect, and his descendants have a tendency to this defect. If two immediate descendants are coupled, this defect will probably be confirmed; whereas, by uniting the descendants of

different individuals, the defect of either of the parents may never break out. But sooner than retrograde by coupling an inferior animal with one in an improved state, we should not hesitate to risk the consequences supposed to arise from what is called breeding in and in, that is, coupling animals nearly related in blood, especially if only on one side, such as the produce of the same male by different females, or of a female by different sires. The qualities which distinguish animals in which the muscles and bones are required to be much exercised, as dogs, horses, and working oxen, are very different from those of animals destined to accumulate mere tender flesh and fat for human food. In the former there must be spirit, activity, and quick digestion; in the latter, indolence and proneness to sleep are advantageous. In the first, the lungs must play with ease, and the muscles be strong, and not encumbered with fat; in the second, the lungs must be sound, as they are essential to all the secretions, and the digestive power must be good, but slow. The food must not be accelerated through the bowels by exercise, but the absorbent vessels of the intestines must draw all the nourishment from the digested food. The more the muscles are impeded with fat, the better the animal will repay the food given him. To choose an animal to breed from, whose produce shall get fat readily, we must attend to this part of the constitution, and care little about spirit and activity. The tendency to secrete bone, and those parts which are called offal by the butchers, as being of inferior value, is a defect. Good flesh and fat are the great objects.

The manner in which the more solid parts of the body are formed, and the greater consumption of food, in proportion to the increase of weight, which takes place in young animals, while bones and horns are growing, prove that it is much more expensive to produce bone than flesh, and muscular fibre than fat. Hence it is evident that the greater profit is in fattening animals that have finished their growth; and also that there is a superiority in those breeds which have small bones and no horns. This is an important point to be attended to by a breeder, as is also the time when the bony secretion is completed. A breed of animals that will cease to grow, or have attained their full size of bone at an early age, will be much more profitable to the grazier than one of slower growth. It is in this respect chiefly that certain breeds of sheep and cattle are so far superior to others. The principles which apply to cattle are equally applicable, *mutatis mutandis*, to sheep. In no case are strong bones or horns of much importance to the sheep in its domestic state. The principal objects are wool and flesh, which appear to be dependent on distinct and perhaps incompatible qualities. The attempt to unite the two is perhaps the reason why the Spanish breed, which has been improved when transported into Saxony, has degenerated in England; so that even its crosses are not in repute. It is a matter of mere calculation, whether sheep kept for their wool chiefly are more profitable than those which give an increase of meat at the expense of the quality of the wool. A breeder of sheep who attends only to the quality of the wool, will not have his attention taken off from the main object by any deficiency in the carcase, or the disposition of the animal to increase in flesh and fat. It is possible that mixed breeds may be more profitable than the pure. Fine wool may not repay the breeder and rearer of sheep so well as moderate wool and good meat. But the principle we contend for is, that of producing the most perfect animal of any one variety existing, by correcting individual defects gradually, and avoiding fanciful crosses, which may destroy in one generation all the advantages obtained in a great many. Hence it is a matter of great importance to consider well the qualities of the individuals with which you begin your improvement, and to know that these qualities have existed in their progenitors, and are not merely accidental. If crossing appear necessary, let it be done very gradually and cautiously. No experienced breeder would ever expect to improve the fleece of a sheep of the Leicester breed or the carcase of the Merino by a direct cross between these two breeds. The offspring would most probably lose all the good qualities for which each breed is noted, and produce a mongrel breed worth little in comparison. But a cross of Merinos with South Downs, or Leicester with Cotswold, might produce new and useful breeds, and these, carefully selected, as has been done, have produced mixed breeds, which by great attention may become very valuable.

When it is determined what breed of animals you wish to perpetuate and improve, the individuals which are to be the parents of the stock cannot be too carefully selected. The more nearly they are alike in form, colour and exterior appearance, the more likely they are to produce a distinct race. They should neither be above nor under the usual size. They should be of such an age as to have entirely ceased growing, and be arrived at perfect maturity; and whatever may be their good qualities, they should not be selected, if they are the produce of very aged parents, at least on the female side.

In horses and horned cattle many breeders prefer a male rather less in size than the female, and pretend that the fœtus has more room to develope its members in what they term a *roomy* female.* There may be some truth in this, but equality of size, or rather the due proportion established in nature, seems most likely to produce a well-formed offspring. Any considerable deviation from this is generally attended with defect. Nothing is more common than for a country gentleman who has a useful favourite mare, not particularly well bred, when any

* See Communications to the Board of Agriculture, by Mr. Cline, vol. iv.

accident has rendered her unfit for work, to have her covered by some very high-bred stallion, expecting to have a very superior foal. Sometimes this succeeds, but in general it ends in disappointment, especially if the mare be small. A much more certain way is to choose a half-bred stallion, nearly of the size of the mare, and having those good points which the mare already possesses. In this case there is every probability of rearing a well-proportioned and useful animal, instead of a *cross made* one, as the breeders call them, probably from the very circumstance of these *crosses* not succeeding in general. We advert to this as a fact which many of our readers may know from experience.

To give in a few words the rules which result from what we have briefly stated:—

Choose the kind of animal you wish to breed from, having distinguishing qualities; keep these constantly in view and reject all individuals in which they are not as perfect at least as in the parents. Select the most perfect forms and let the defects be corrected gradually. Have patience and perseverance and avoid all attempts at any sudden alteration by bold crosses. If possible, breed two or more families of the same kind, keeping them distinct, and only occasionally crossing the one with the other. In this manner a very improved breed may be produced. The nearer you approach to perfection the more difficult will be the selection, and the greater the danger of retrograding. Hence in very highly bred stocks it is often almost impossible to keep up the perfection of the breed, and a fluctuation in the quality of the produce will take place. The more improved the breed is, therefore, the greater attention must be paid in the selection of those which are to continue it. And for want of this, almost every breed, however reputed it may have been at one time, gradually degenerates, and loses its great superiority.

We add on this subject the following passages extracted from a lecture by Mr. S. Evans, M.R.C.V.S., lately (April, 1859) delivered before the Wenlock Farmer's Club. He said:

"The first great law of nature in breeding is, that like should produce like; but it must be accompanied in our mind with another law, the law of variation. One of the causes of variation is what is called 'breeding back.' It is often a source of disappointment to the breeder that when he puts a well-formed female to a well-formed male, he gets an ill-formed colt or calf, and of quite a different colour to what he expected. If you inquire into the pedigree of the parents you will find the child answering in every respect to the description of an ancestor. It is this that makes many say that horse-breeding is a lottery. However, if you breed properly you have little to fear. Pure and thorough-bred animals comparatively seldom breed back, or disappoint their owners in doing so. By thorough-bred is meant those whose ancestors were for a long time of the same shape, and adapted for the same purpose as themselves. The more the animals have been crossed the more subject are they to breed back, and the more the difference of shape in crossing the more likely is breeding back to prove a disappointment. This should make you very careful in breeding stock, and to ascertain that not only the sire and dam are free from spavin, curbs, &c., but that their ancestors were not subject to any hereditary affection, and not only that they were free from hereditary evils, but that they possess the same good qualities, and are adapted for the same purpose as themselves. Now comes the vexed question, Which has the predominating influence on the progeny, the male or the female parent? If both parents join to form the child, does one parent give one group of organs and the other parent another group; or do both give all?

"It is not fair to look at one set of facts alone, and shut our eyes to others. It is by an impartial survey of them all that we get the truth. There is an able article upon this subject in the 'Westminster Review,' which says that both parents are always represented in the offspring; and although the male influence is sometimes seen to predominate in one direction, and the female influence in another, yet this direction is by no means constant, is often reversed, and admits of no absolute reduction to a known formula.

"It is a common but silly question, Which breed of animals is the best for the farmer? Some advocate short-horns, others advocate the long-horns.

"That breed of animals is the most profitable which is best adapted for that particular locality. One class does better on upland, others on lowland; some do better grassing, others do better housed. It also depends upon the demand of the neighbouring markets. In some parts cheese-making pays best; in other parts milk; in other parts meat, &c. In some districts it pays better to breed draught horses, in others hackneys and hunters, in others racehorses, in others ponies, &c. Every breed has its own peculiar conformation, and that conformation you will find upon close investigation to be peculiarly well adapted for a particular purpose; and when you adopt and cultivate a certain breed, you must always keep that purpose and that conformation steadily in view. If you lose the conformation, you will soon lose the purpose. For instance, we may divide cattle into two primary classes: 1, for fattening and arriving at early maturity; 2, for dairy purposes. We may also divide horses into two primary classes: to carry weights on the back, and go fast; and to draw weights after them. It is evident that they are destined for very different purposes, and must set to work in a very different manner. There is a peculiar

shape adapted to perform any particular work, and it is essential that the young man should make himself thoroughly acquainted with those before he can be expected to be a successful breeder. Starting then upon the great law of nature, that like produces like, and being prepared to guard against variations by breeding from animals of the same sort, &c., breeding good stock becomes a simple matter of course. First ascertain what animals your land is best adapted for. Secondly, what have the readiest sale in your markets. Thirdly, having decided upon the purpose of your animal, study the best shape and conformation calculated to attain your object in a most perfect manner; if you wish to breed fat stock, study the shape most disposed to lay on fat with the least food, and to arrive at early maturity; if you wish to breed milk cows, study the proper shapes for them; if you breed horses, study the proper shapes to perform their various duties. Fourthly, don't breed from an animal, whether male or female, whose shape is not well adapted to perform the work it is intended for: let them be of the most perfect shape you can get of their kind. Fifthly, being acquainted with the law of breeding back, you will not be satisfied unless their ancestors were also of the same sort, and equally good; in fact, thorough-bred, and free from hereditary evils. Remember the term thorough-bred may be equally well applied to the cart-horse, or hunter, or pony, or carriage-horse, &c. It means those whose pedigree for a considerable time back were of the same class, and adapted for the same purpose as themselves. Unless you commence to establish a new breed, you should never breed from a half-bred animal. Let them all be castrated. There is too much risk connected with it; it is based upon a wrong principle; you should carry the right principle out thoroughly. Why should you breed from a half-bred mare more than from a half-bred cow? Some may say that you have no pure or thorough breeds, except racers; therefore you ask how can you avoid crossing. Well, 'It is never too late to mend.' By breeding exclusively from animals of the same shape, and, therefore, adapted for the same purpose, with careful attention to pedigree, you may easily establish a breed for any purpose whatever."

As every farmer and occupier of land is more or less a breeder, if he be only a breeder of pigs, these observations may be useful. In the articles on each particular species of animal, these general principles are applied and more particular directions are given.

BREHON LAWS. The ancient laws of the Irish, so called from being expounded by judges, named in the Irish language *Breitheamhuin*, or Brehons. *Feineachas* however and *Breitha-neimeadh*, words said to signify respectively ancient laws and sacred ordinations, are the terms commonly applied to the collection of these writings by the native writers.

Prior to the Anglo-Norman invasion, Ireland was wholly governed by the Brehon law; and, notwithstanding the statements of Spenser, Sir John Davies, Cox, and others, that this was an unwritten and barbarous code, there is abundant evidence to prove that some of the collections of the *Breitha-neimeadh* are of equal antiquity with the oldest manuscripts of Irish history, whether civil or ecclesiastical, an antiquity which carries us safely back to the earlier ages of the Christian æra. The extant collections are numerous and authentic, but the labour of translating and methodising them, though a most desirable service, has been long neglected. It is, however, now entrusted to the very competent hands of Dr. John O'Donovan and Mr. Eugene Curry, for whose labours during the last few years the British parliament have voted considerable sums of money; and, when completed, the results are to be printed. Nothing has yet appeared, but still we are not altogether ignorant of what the Brehon laws were. The 'Encyclopædia Britannica,' under the head 'Brehon Laws,' published in 1854, says, "there are, it is said, in Ireland, ancient MSS., the publication of which would throw light on this curious and interesting subject. Till such elucidation be afforded, of which some prospect is held out, it were useless to hazard opinions on the character and value of the Brehon Laws as a system of jurisprudence." The "it is said" is somewhat disingenuous, when an elaborate article on the subject had appeared in the 'Penny Cyclopædia' in 1836. That article we now reproduce. Within our limits, of course, it is not possible to do more than give such an outline of the social system of the old Irish under these laws as their available fragments, compared with the general history of the country, would point out to the reader of the various accessible authorities on the subject.

The present division of Ireland into provinces, counties, baronies, and townlands, would appear to correspond pretty nearly with the old territorial distinctions of minor kingships, lordships of countries, chiefries of clans, and presidencies (if we may use the term) of villages; all subject to the dominion of the *Ard Righ*, or supreme king, and tributary, one to another, among themselves.

The law governing this community is distinguishable into the common and, so to speak, the statute law. And, first, as to the common law, or immemorial custom of the country, our information is necessarily scanty, as being derived chiefly from the reference made to such usages in the remaining fragments of the written law; for at this day there remains scarce any oral tradition available on this subject in Ireland. The constitution of the bulk of society in ancient Ireland was patriarchal and pastoral. By the common law of the tribes, the ground belonging to each seems to have been divided into common pasture lands, common tillage lands, private demesne lands, and

demesne lands of the tribe. Each man of the tribe had then the right to pasture as many cattle as he possessed on these common grazing lands; and in proportion to the number of cattle thus pastured by each was the share of the common tillage lands assigned to him on the annual partition or hotch-potch of the lands. The private demesne lands were the distinct property of individuals who were entitled to acquire and transmit such possessions by certain qualifications not very clearly explained. The demesne lands of the tribe were set apart for the maintenance of the chief, the chief elect, the bard, doctor, and brehon.

With regard to the nature of the property enjoyed in these several estates, the tribe at large possessed what is called the allodial or original indefeasible property in all the lands, and could not be ejected out of them in consequence of any arrears of tribute, inasmuch as the superior lord lifted only a proportion of the increase of stock upon the pastures, and was bound to take the same away at certain seasons; this rent was precisely a lay tithe, being one-tenth of the increase. As to the common tillage lands, every member of the tribe possessed a life interest in them, proportioned to his stock in cattle. In the private demesne lands individuals had a permanent inheritable interest. In his separate portion of the demesne lands of the tribe, the chief had a life interest, of which the reversion lay with the tanist, that is, the *second man*, or chief elect, and in like manner the tanist, bard, &c., possessed life interests in their several portions.

The personal distinctions of the tribe, corresponding to the above territorial divisions, were, so far as can be gathered from the very confused authorities on this head, the *In-finné*, holders in common, and the *Dathaig-finné*, those individuals alluded to above who were entitled to separate inheritable possessions. The *In-finné*, or commonalty of this pastoral corporation, appear to have been of one rank; but the *Dathaig-finné* were divided into several classes, of which the three most intelligible were, the *Deirbh-finné*, or class, as the commentators explain it, nearest the succession, who had the right to inherit the whole patrimony of their kin without deduction; the *Gall-finné*, who inherited three-fourths of their patrimonial estates; and the *Iar-finné*, whose right of inheritance extended to only one-fourth of the property left by their relations. These privileged classes were in every tribe limited in number; but it does not exactly appear what was the qualification for admission, or the rule of exclusion, or whether the *Deirbh-finné*, for instance, became disqualified on the election of a tanist less nearly related to them than to others, although it is evident that a man might rise from the condition of a tenant of common tillage to that of a freeholder, or *vice versâ*, descend from the higher class to the lower. As to the chief himself, he was usually elected before the death of his predecessor; and the rule seems to have been invariably, that the eldest of the candidates, if not incapacitated by age or infirmity, should have the preference, the brother being commonly chosen instead of the son, and the son rather than the nephew. His revenue arose, as has been said, from the tenths of the increase of cattle, and from the revenues of his demesne lands. In addition, he had certain claims of entertainment for himself and household at stated times in the houses of his tenants, in the same manner as his superiors, at certain seasons, quartered themselves or their soldiers upon him. These claims were sometimes compromised by both for an equivalent in tribute; but as a portion, more or less, by way of homage, was generally reserved, and as the reservation, according to its extent, would seem to have had a special denomination, we have an explanation of the perplexing multiplicity of exactions which has so frequently called down the censure of our early writers, who seem to consider *coyne*, *living*, *bonaght*, *sohoran*, *cuddy*, &c. &c., as so many separate taxes, leviable on one and the same holding—an extortion apparently monstrous, and really impracticable, since there are as many denominations of tribute, according to its reserved extent, as, if added together, would amount to perhaps three times the value of the whole land.

So far of the *Finné*, or original members of the kindred, who constituted the great majority of the tribe. But in every tribe there was another class, less numerous and generally less honourable, but in many respects peculiarly interesting and important, particularly as regards the origin of the *feudal law*. The subject of feudal tenures has occupied the attention of the most distinguished English lawyers and historians. The origin of the system has been in all cases referred more or less to the necessities of military conquest, and its genius has been invariably considered as quite distinct from that of any pastoral constitution. The remains of the brehon law however would go far to show that the feudal and pastoral systems, if not to some extent identical, have been in their origin closely and necessarily connected. The system laid down above is so far calculated for the government of a society composed of tribes, each tribe possessing the allodium of its own district, and the mass of its members holding in common. But co-existent with the first practical development of such a system, if not actually contemplated in its very rudiments, arises the necessity of providing for those members of the community who, either by chance, or choice, or compulsion, have been separated from their particular kindreds, and have thus no proper *Finné* with whom to claim a share. Such individuals could not expect to participate in the rights of blood enjoyed by those tribes among whom they might be dispersed, neither could they be received by the commonalty of those tribes as tenants on their fluctuating possessions. To provide for them, it was necessary that a certain portion of the land should be set apart for the reception of strangers. To prevent the confusion of many landlords, the profits of these tenements were allotted to the chief, who could thus afford to exact a lighter tribute from the *Finné* of his tribe. To induce the better sort of strangers to settle among them, the chief was empowered to grant some of these tenements in perpetuity, but the greater portion was usually let at will. As for those who had only their labour to offer in lieu of the chief's protection, they were received on his private demesne lands, and became his serfs. Admission to the upper class depended on the stranger's ability to pay the entrance fine on one or more of the disposable tenements. These tenements consisted of a homestead with a certain scope of ground annexed. The homestead was denominated a *Rath*; to constitute a legitimate rath five things were requisite, namely, a dwelling-house, an ox-stall, a hog-sty, a sheep-pen, and a calf-house: these buildings were generally surrounded by a ditch and rampart, and formed if necessary a place of defence as well as of residence. There is one very prevalent error with regard to raths in Ireland; namely, that they were Danish erections, and designed solely for military occupation. The term "Danish rath" is altogether a misnomer. The original titles of raths, according to the classification of the brehon law, were drawn solely from the circumstance of their erection and occupation by the natives themselves; as for example, among many others, the *Finné-rath*, a homestead occupied by the original kindred; a *Mer-rath*, one rented by stranger tenants for the first time; an *Iar-rath*, one occupied by stranger serfs on the chief's demesne lands; a *Saer-rath*, one of which the stranger tenant enjoyed the perpetuity; a *Forgu-rath*, a secondary tenement appurtenant to the *Saer-rath*, &c. &c. The entrance fine of such a tenement was denominated *fal*, and for the legitimate rath amounted to fifty head of cattle. But the most important term in this vocabulary is that applied to the stranger tenant himself. As distinguished from the *finné*, or original clansman, the stranger tenant was called *Fuidhir*, and his tenure *Fuidh*. Now these terms are pronounced respectively *Feuer* and *Feu*, the identical words still employed in Scottish law to indicate the freeholder and his freehold. Hence that they are the radical form of the other feudal derivatives, such as fief, fee, &c., seems more than probable; and when we come to consider more closely the relative situation of the Irish ree-feuer, it will appear that there is something in it very analogous indeed to the older forms of pure feudal tenure. First, the allodium of the soil vested in the representative of the tribe, so that the tenure of the ree-feuer holding of the chief might be considered as *in capite*, with a power in many cases of granting mesne tenures to others. Secondly, at the death of the chief a stated fine was paid to his successor. Thirdly, females could not inherit. Fourthly, raths were liable to escheat; and Fifthly, the tenant was bound to serve the chief in war, and to diet certain numbers of his soldiery at all seasons. Of the more minute characteristics of the perfect feud as introduced by the Normans into England, such as escuage, wardship, ransom, &c. &c., there are so far few discoverable traces, but enough has been shown to give good ground for considering the Irish law of feuers, connected as it necessarily was with the pastoral constitution of their society, as the original form of feudal tenure among all the Celtic nations. Feuers were classified according to the circumstances of their migration; as those who had voluntarily left their former tribe to seek their fortunes; those whose tribe had been dispersed in war, and those who had fled or been expelled their tribe for debt, for robbery, for piracy, or murder. The first three classes only had the privilege of becoming ree-feuers; criminal fugitives were admitted only to a temporary protection, which they paid for by cattle or hand-service, on the private demesne lands of the chief, until he should compound with his prosecutors, after which they usually became his serfs or bondsmen. In the 'Annals of Ireland, translated from the Irish of the Four Masters,' by Messrs. O'Donovan and Connellan, it is stated that the usual mode of descent was by gavelkind. Bond-feuers were attached to the soil; the lands to which they were assigned being denominated Betagh lands, and they themselves being frequently granted with the soil, as appears in many ancient deeds, where they are specified under the name of Betaghs.

Thus then it would appear that the country was occupied by kindreds called *Finné*, holding for the most part in common, and by *Feuers*, who were either tenants by rent and service, or vassals of the chief. The tributes of chief to superior chief, up to the supreme king of the whole island, were regulated by established precedents. The collection of these rules for the kingdom of Munster is entitled 'The Book of Rights,' and is still extant.

So far of the common law; next as to the statute law of the Irish. Whether these particular enactments were decreed by a general assembly, as asserted by some, or by local chiefs, as affirmed by others, is a question not at present capable of satisfactory consideration. The books containing them, of whatever age, profess to be but transcripts and collections, with frequent references to similar compilations of still older date; but the text appears to be original, as its dialect is so antiquated as to require the assistance of frequent glosses, themselves very difficult to be deciphered, and even when translated not by any means easily understood. The collections are interspersed with numerous moral sentences, occasionally also with superstitious dogmas: as an instance of the first, "Heaven is like a chariot on wheels, the more you push against it the farther it flies from you;" and as an example of the second, "There are seven witnesses against a wicked king;

namely, division in his councils, strained interpretation of the laws in his court, dearth, barrenness of cattle or lack of milk, a blight of fruit, and a blight of seed sown in the ground: these are as lighted candles to expose the misgovernment of every king."

The number seven would seem to have been held in much the same esteem as the mystic number three. There are, for instance, "seven classes of persons whose anger is not to be resented; namely, bards, commanders, women, prisoners, drunken persons, druids, and kings in their own dominions." There are again "three deaths not to be bemoaned; the death of a fat hog, the death of a thief, and the death of a proud prince: three things again which advance the subject; to be tender to a good wife, to serve a good prince, and to be obedient to a good governor." In this last example the same idea is repeated in order to complete the triad. What virtue can have been supposed to reside in these peculiar forms of expression it is hard to conceive. The only assignable reason for their use seems to be that they were thus more easily committed to memory. The system however does not appear to have been used to any such extent in Ireland as in Wales; triads, in fact, form the bulk of Howell Dhu's laws, and those of the most arbitrary and absurd description.

But to proceed with the more practical and intelligible portion of these collections, the laws defining specific crimes and their punishments. It is said that previous to the reign of Felimy Reachtair, or the Lawgiver, the *lex talionis* prevailed in Ireland, and that he altered that code for a system of retribution by mulct about A.D. 164. Parricide, rape, and murder, under certain circumstances, still remained punishable by death; but whether in consequence of this reform in the old law, or by immemorial custom, all other offences were thenceforth provided against in the brehon law by definite fines. The retribution thus exacted was denominated *eneclan* or *eric*, terms applicable also to rents, prices, and value in general. This system of erics has been justly censured by all English writers on the history of Ireland. But in this, as in most other instances, the censurers of the Irish have exaggerated the evil by considering it as peculiar to that people. So far however from being confined to the Irish, this mode of retribution by eric has been practised at one time or other by almost all the nations of Europe. The Greeks, the Romans, the old Germans, the Franks, the Saxons, the Welsh, all punished our present capital offences by a fine. The only difference lies in the word to express it, *poine* (*poena*), *mulcta*, *weregild*, *manbote*, *sarhaad*, and *eric* being synonymous terms in their respective languages. In England at the time of the Conquest, every man had his value; in Wales, even to the time of its incorporation with England, not only had every man his own value in gross, but the particular value of all his members severally laid down by law, as six oxen and ten shillings for the two hands, a like sum for the two eyes, half that sum for one of either pair, so much for the ears, lips, nostrils, &c., and these again varied with the rank of the maimed individual. It is not then to be considered either unexampled or monstrous to find an Irish chieftain requesting of the lord deputy to fix his sheriff's eric, that he might know what he should have to pay, in case of that officer coming by his death at the hands of any of his people. The amount of these erics, the different persons liable for their payment and entitled to their receipt, the proportions of these claims and liabilities, the adjustment of value and the living money by which the various proportions of the mulct were paid, these and the further punishment of the offender in each case required a very minute and complicated system of enactments. That the old Irish were acquainted with coined money is asserted by numerous authorities; that they used large quantities of the precious metals as a medium of value is unquestionable; but as none save chiefs and lords of territories were required to pay tribute in metal, the dealings of the mass of the people were calculated for the standard of living money as closely as the nature of the medium would permit. Cattle were accordingly classified; and no doubt it would raise a smile on the countenance of a modern merchant to be told of calves, yearlings, heifers, strippers, in-calf cows, &c. representing the fractional parts of the standard of currency, but such has been the original pecuniary substitute in every country; and when we have the learned Selden declaring that "pounds and shillings were not abundant in England in 1004, but paid in truck and cattle," we can consider the practice in a less intolerant spirit than those who, writing but a few centuries after the use of coined money had become common among their own countrymen, have represented the barbarism of the Irish in this respect as a thing almost unheard of before. It has been seen that in proportion to the number of cattle possessed by each member of the tribe was his share of the common tillage lands. Thus cattle were not only the standard of value, but the qualification for, and a necessary concomitant of, property. The land was thus by a sort of legal fiction an appurtenance of the stock; so that to say of a person under this system that he possessed a hundred cows, implied not only that his herds amounted to so many head of cattle, but that in addition, and as a necessary appurtenance of his estate in them, he also possessed the grazing of a hundred cows, and the share proportioned to a hundred cows in the common tillage lands of his tribe. Every addition to the number of a man's cattle was therefore a virtual accession of land and produce, and *vice versâ;* and thus a mulct of cattle fell as heavily on the granary as on the larder or dairy of the fined individual; for these proportionate partitions of the land took place at stated periods, and each man's harvest fluctuated with his

herds as they bore a greater or less ratio to the aggregate of all the cattle of the rest. The division of the ground into portions so uncertain precluded the use of permanent fences on those arable commons which were probably separated from the pasture by only one exterior circumvallation, while each man knew the portion that was to fall to his particular reaping-hook within. The adjustment of these portions must have been a matter of some difficulty; from an account of a partition of this kind given by Sir Henry Piers, who wrote a history of the county of Westmeath in the year 1682, it would appear that the plan usually pursued was this. The land was divided into equal shares, in the proportion, each to the whole, of the herd of the least proprietor to the whole *creaght* or common stock of all their cattle. These shares were drawn for by lot, in order to give to all an equal chance of getting the worse or better land. He then, it is supposed, whose herds were thrice as numerous as those of the least proprietor, drew three such aliquot parts; he possessing ten times as many, ten such, and so on, the shares being taken here and there as they turned up, and every man cropping his own portion as he thought fit. The system is still remembered in some parts of the country, and a mode of expressing the extent of land among the Munster peasantry is still to say "So much as *follows* so many cows." Hence, in all likelihood, the term *Bally-boe*, that is, cow-land, a term which has perplexed many writers, in consequence of the varying extent represented by it at different times and in different districts. It appears therefore that by levying all mulcts for infringements of the law in living money, the Irish brehons took the most effectual mode of making their punishments tell on the whole condition and standing of the offender in his tribe, for punishments so inflicted showed themselves, more or less, in every circumstance of his life and fortunes, and affected his landed property in all cases for a whole year at least.

In calculating by the measure, it was necessary again to fix a standard of available aliquot parts. The number three was found most convenient, and accordingly the *cumhal*, a general expression of fixed value, was made to consist of three in-calf cows, and by multiples and fractions of this quantity all other proportions of value were usually regulated. Seven *cumhals*, or twenty-one cows, was the usual eric for murder on the highway. This will appear, at first sight, a very inadequate retribution: but as it is not quite clear whether the relatives of the deceased could not severally recover an eric from the murderer, and as it is an accompaniment of the punishment in this offence, that the criminal loses all right in the common tillage lands of his tribe, no matter how numerous his herds may be, after satisfying the judgment of the brehon, his punishment may not perhaps have been so much disproportioned as it would otherwise appear. Still the possession of numerous herds might thus purchase the wealthy man a privilege of violence. To guard against this, the liability increased with the rank of the culprit. Taking the liability of the ordinary clansman at one, that of the wealthy boor (*bo-aireagh*, pronounced *booaré*, that is, a person rich in cattle,) would be represented by two; that of the flaith, or petty chief, by three and a half; and so on to the righ or lord of his country, whose liability is raised in the proportion of seven to one. Robbery was punished, in like manner, with this salutary provision, that if the robber could not be discovered, the holder of the stolen goods should pay his eric. The sanctity of marriage was strictly guarded: the injured husband had his first redress at the hands of his father-in-law; failing him, he might levy retribution on his wife's brothers; failing them again, on her foster-children; and finally, if she had no relations, or if none of them were solvent, her tribe at large had to pay the penalty of her crime.

Next to these, the fines for trespass appear to have been attended to with peculiar strictness and care. Hitherto we have spoken of lands held in common, whether for pasturage or tillage, where there could be no fences, and consequently little trespass; but, before we enter on the code of trespass-eric, it will be necessary to recur to those lands which we have denominated the private demesne lands of the tribe in which the *Deirbh-finné* possessed their distinct inheritance. In the present state of the inquiry, it cannot be precisely ascertained how this inheritance was acquired; but such lands are frequently alluded to in the original laws, and distinctly recognised by Sir James Ware, who admits them to have been freeholds. These lands not being subject to yearly repartition, were permanently defined and fenced, and the exclusive possession enjoyed by their holders is evinced by the extreme jealousy of the law decreeing their inviolability. First, we have the legal fence defined; namely, a trench, two feet in width at bottom, three feet in depth, and three feet in width at top, with a ditch raised on one side, of these dimensions and materials, namely, twelve hands of stone-work three feet thick, twelve hands of sod over that, then wooden stakes two feet asunder driven firmly into the sod, laced with wattles, and rising three hands over all. For breaking through a fence so constructed, the legal fine was thus proportioned: for every breach up to the breadth of three stakes, a heifer or young bull; for every breach above three and under five stakes, a bull full grown; for every breach over five and under eight ditto, an in-calf cow; up to twelve ditto, five cows, and so on in progressive increase. That these lands were considerable enough to be extensively wooded, appears also from the penalties against trespass on timber. The classification and comparative valuation of trees in a country which has usually been considered a wilderness of

forests cannot fail to be interesting. Timber was divided into four classes—airigh, athair, foghla, and losa timber; and the fines for trespass on each were thus proportioned: airigh timber, namely, oak, ash, hazel, holly, yew, and fir—for cutting the trunk, five cows; for cutting or maiming the limbs, a heifer; for the branches, a two-year old. Athair timber, namely, alder, willow, hawthorn, quick-beam, birch, and elm—for cutting the trunk, a cow; for the branches, a heifer. Foghla timber, namely, black-thorn, elder, spindle-tree, white hazel, aspen, arbutus—for each a heifer. Losa timber, or fire-wood, namely, fern, furze, briar, heath, ivy, broom, dwarf thorn—the penalty for destroying [these to be at the discretion of the brehon. Full as the classification here is, it scarcely equals in minuteness that law of Ina, a king of the West Saxons in the tenth century, which estimates the value of a tree by the number of swine its branches could give shelter to.

But perhaps a more remarkable law is that of the Irish brehon regulating the property in bees. Honey and wax must have formed a large portion of the wealth of those days, else the various contingent interests in a species of property so hard to fix as that in a swarm of wandering bees had never been calculated and laid down with such scrupulous nicety. In the first place, the bees themselves are protected by severe enactments against injury of whatever kind. Next, they are to be left free, under heavy penalties, to choose their own place of swarming: "to blind the bees" by casting up dust, or taking any other means to force them to descend and swarm on one's own land, while they are flying out of the lands of another, was an offence for which the punishment was no less than expulsion from the tribe and territory. The bees having voluntarily selected and settled on a tree, it then depended on the rank and privileges of the owner as well of the bees as of the tree they had chosen, what was to be the portion of wax and honey reserved for each, and how long the original owner should continue to receive that share, as the bees in all cases ultimately became the property of him upon whose tree they had alighted. The commentators on the old text here complain very bitterly of the clergy, who, it would appear, were particularly fortunate in attracting such wandering swarms to their abbey orchards, where they did not scruple to cover them with sheets, and take other unfair means of securing their stay among them. If the bees, however, were found beyond the sound of a church bell, or the crowing of a cock, in the woods or meadows, the finder was entitled to the whole proceeds, excepting a ninth part, which he had to pay by way of tribute to the chief. If these laws have been rightly translated, the old Irish must have possessed the secret of abstracting the wax and honey without destroying the swarm. In no other collection of laws are the regulations regarding this species of property so copious; in fact, it would require all the space here devoted to this subject to explain the minute and complicated decrees of the brehon law regarding bees alone.

It is equally impracticable to enter fully into the law of water-courses, the enactments on which are very remarkable, inasmuch as the property of the whole water of a stream vests in him out of whose land it first springs, so that the owner of the fountain could levy tribute even on those bridges which crossed the river between banks belonging to other men, as well as on all houses (save those of the chief, the head villager, and the miller,) whose occupants drew water either from the fountain or the stream. Millers were a class peculiarly favoured in these laws: their mill-races were tax-free; their mill-wrights, while pursuing their trade, could not be prosecuted for trespass; and, as above stated, their households were exempt from tribute on all water drawn for their consumption. It is worthy of remark, that by the Jewish law the mill-stone could not be confiscated.

The law of rivers and sea coasts is also laid down at some length; but of the law of roads only one section hitherto has been found. This section, however, is well worth notice, as it contains proof of a much more general design in these laws than we might otherwise be disposed to give them credit for. It provides that the space of the cast of a dart shall be left from high-water mark along the sea-shore for the construction of a public coast-road round the whole kingdom. It is said that some traces of such a road are still to be seen upon the Irish coast. Vallancy states that in his day the country people called it *Brian Boru's road;* and other writers mention the remains of a great inland causeway somewhat similar to the British Watling Street, crossing the country from Dublin to Limerick, which was probably the effect of a similar provision for inland communication.

The law of fosterage is more fully stated. Every member of the *Dathaig-finné*, or gentry of the clan, was bound to send his male children to foster with some family of the *In-finné*, or commonalty; for it was provided that none but fosterers could claim full eric. The *Ægairer*, or foster-fee, was a stated sum payable by instalments during the child's minority. While the child was thus under age, the foster-father was bound to pay one-half of his fines, in return for which the young noble or idil-man was ever after bound to protect his new kindred, and in particular to pay all fines incurred by his foster-mother, except in case of adultery, when the liability first fell upon her father and brothers, if alive and solvent.

The law of tuition provides for three chief branches of education, namely: knowledge of cattle, as being the first and most important in a pastoral community; next, knowledge of agriculture; and, finally, of

navigation; instruction in letters being an indispensable branch of each. These attainments were acquired under tutors hired for the purpose, and paid by the father or foster-father, according to the arrangement of the *Ægairer*, the foster-father himself being always the youth's instructor in all military and athletic exercises. The tutors alluded to were the *ollamhs* or bards, who also acted as clerks and notaries under the brehon. The offices of these functionaries, as well as of the physician, were hereditary, but not, as is generally supposed, subject to the law of primogeniture; the judge, poet, or doctor, being at liberty to select from all of his own name those apprentices whom he might think most promising in his peculiar profession. The brehon, as a judge, was held personally in great reverence, and was always considered as a neutral in war.

The law of physic proportioned doctors' fees to the rank of the patient, and the nature of the complaint. If a cure was not effected, the doctor had no pay; but where the treatment proved successful the recompense was very liberal, as fourteen *cumhals* or forty-two cows for the cure of a bishop or provincial king, seven and a half *cumhals* for that of a lord of a country, three for that of a *bovaré*, and two for a member of the commonalty.

It is disputed whether the new series of enactments were sumptuary or merely valuatory. Dr. Ledwich adopts the latter opinion, but the tenor of the translated fragments would seem rather to imply the former. They are said to have been enacted by Mugdories, the daughter of Mogha Muadhad, a king who lived in the 2nd century. By them a certain value is established for various articles of dress and luxury; as, for example, a mantle wrought with the needle is valued at a steer or heifer. The dress of a petty chieftain's lady is estimated at three cows; that of a head villager's wife at two; that of a bard and his wife together at three; and that of a bishop at six. The bodkin or brooch of any one under the rank of a *bovaré* was in like manner priced at three heifers; that of a *bovaré* at five; that of a Flaith or petty-chief at ten; and that of a king or lord of a country at thirty. Of the same value in each degree was the bridle. The belt was estimated proportionately at about a third; and in like manner with regard to arms and armour, drinking-cups, &c. &c.

As to forms of trial, there is nothing preserved which so far throws any light upon this portion of the inquiry, except one very interesting fragment, namely, cases of disputed inheritance of lands were to be judged by twelve voices, one dissentient voice invalidating the verdict. This was the ancient law, and the commentator observes that the hardship of its extreme strictness occasioned its practical repeal.

Such, so far as has been hitherto collected from the ill-arranged and defective materials, would appear to have been the old system of rude jurisprudence under which the Irish people lived prior to the invasion of the Anglo-Normans in the 12th century. The conquerors brought their own laws with them; but the progress of the more complicated and formal feudal system of the continent in displacing its primitive originator and rival was necessarily very slow. The brehon law offered many attractions to ambitious individuals desirous of establishing a self-contained despotism in each of their several territories; and while the particular duties and services done by the new feudal law were rigorously exacted, the general privileges of the English constitution were denied. The subjects of the Anglo-Norman conquerors thus participated in the evils of both systems; for the protection of judicial trial by the law of England could not be claimed by the serfs of remote districts; and the power of the conquerors was too arbitrary to permit any operation of the brehon law within their bounds which was not for the sole interest of the lord; thus, the poor native of the pale was mulcted under both laws and protected by neither. It is not surprising, therefore, that the lapse of a Norman noble into mere Irishism, by which he acknowledged the brehon code alone, was anxiously encouraged by his dependents; and such were the inducements of the system itself for turbulent and ambitious spirits, that few of the adventurous nobles who first established themselves in Ireland resisted the temptation. To guard against defection so ruinous to the whole policy of the conquest, many statutes were enacted in the parliaments of both countries. These at first were for the encouragement of the English law only, but afterwards it became necessary to take measures of prevention as well as of discouragement. The first positive act against the practice of the brehon law within the pale was passed by the parliament held at Kilkenny by Lionel Duke of Clarence, in 1362; by which the offence is declared high treason. This was followed by the 18th Henry IV. c. i. ii. iii., and the 28th do., c. i., with similar prohibitions and penalties. The prohibition, however, had little effect. The open defection of the great families of De Burgho, Bermingham, and various branches of the Fitzgeralds, in Ulster, Connaught, and Munster, kept the dangerous example constantly before the eyes of the nobility on the borders of the pale, and each successive rebellion tended to increase the evil: for if the government were successful, the border barons, on whom the maintenance of that advantage afterwards depended, were proportionably more indulged; and, if the Irish prevailed, their yielding under such compulsion was the more excusable. A good example of the anomalous state of society produced by the intermixture of the two systems on the borders of the pale may be adduced from the reports made by various corporate towns of Leinster to the commissioners appointed by

Henry VIII. to inquire into the abuses of the Irish nobility in 1537. The following is an abstract of some of the most remarkable complaints. "All the freeholders, lay and spiritual, charged their tenants *coyne* and *livery*, with *foy* and *pay*, with *summer-oats*, with *cudies* and *cashies*, with *black-men*, with *black-money*, with the maintenance of *mustrons*, and with *carriage* and service in general. Lord Kildare and Lady Catherina Poer not only required coyne and livery for their own horses and boys, but also for those of all their guests, English or Irish, particularly when they kept Easter or Christmas. When either he (Kildare) or Poer, or Ossory, hunted, their dogs were supplied with bread, milk, or butter. When the deputy or any great man came to Lady Poer, she levied a subsidy at her pleasure for meat, drink, and candle, under the name of '*mertyagh*.' When Ossory or Poer married a daughter, the former demanded a sheep from every husbandman, and a cow from every village; and when their sons were sent to England, a tribute was levied on every village or plough-land. Lady Poer took of a tenant who had his horse or cattle stolen, 5 marks for his want of vigilance. Sir Thomas Butler exacted 10 marks at Easter, if his subjects had passed the year without galenglass or spearsmen. William Bermyngham required 16 quarts to the gallon, in payments by liquid measure. Some lords took the tenants' produce at prices fixed by themselves, and thereby were enabled to forestall the markets. The brehon, who was kept by Lady Catherina Poer, took for his judgment, called 'sylogag,' 16*d*. of every mark sterling, both of the plaintiff and defendant, &c., &c." By these tyrannical practices, resulting from the union of the worst parts of both systems, the brehon law fell into extreme odium, but they are chiefly the exorbitancies and malpractices of the class which have been quoted by English writers who censure it; so that if the views here taken be correct, that odium has been in great measure undeserved. Indeed the nobles of the pale seem to have established a separate code of laws for their own government, known as the *Statutes of Kileash;* and we find them, in the reign of Henry VIII., inflicting a penalty of five marks on the individual who would sue by any other law. If these statutes be the index to such practices as those quoted above, it is little to be wondered at that the brehon law, which bore the blame of all, should have been denounced as it was. Great efforts were accordingly made, both in this reign and in Elizabeth's, to supplant the brehon law; the 3rd and 4th Philip and Mary, c. v. is also directed against some of its effects; but it was not till the 3rd of James that the final extirpation of the old law was effected. The whole kingdom being then divided into counties, with their several sheriffs and circuits of assize, the brehon law became a mere subject of inquiry to the antiquary, and as such, at the present day, possesses perhaps greater interest than any other branch of Irish or Celtic archæology. We may now hope ere long to see a full and perfect translation, which cannot fail to throw much light on the accounts of the early state of civilisation in Ireland.

BREIDIN. A crystallisable substance, found in the resin of the *Canarium album*.

BREIN. A fusible, crystallisable, neutral body, existing in the resin of the *Canarium album*.

BREVE, in Music, a note double the length of a semibreve, and thus formed, ‖ o‖, or ‖ =‖. The *breve* (from *brevis*, short), which in duration takes twice the time of the longest note now in ordinary use, was a short, brief note, three centuries ago, as the term clearly proves. Musicians have proceeded by degrees till the quarter-demisemiquaver is become our *minimum*, being $\frac{1}{256}$ of the breve. Indeed some have gone so far as to introduce the half-quarter-demisemiquaver; among whom is Beethoven.

BREVET, in France, denotes any warrant granted by the sovereign to an individual, in order to entitle him to perform the duty to which it refers.

In the British service, the term is applied to a commission conferring on an officer any degree of rank *in the army* above that which he holds in his particular regiment; which, however, does not carry with it the corresponding pay. Brevet rank does not exist in the royal navy, and in the army it neither descends lower than that of captain, nor ascends above that of lieutenant-colonel. It is generally given as the reward of some particular service, though it used to be the custom to give periodical brevets, by which all officers of a certain standing received a step of brevet rank.

Brevet rank does not promote an officer over the heads of those in his own regiment; but when serving on courts-martial formed of officers drawn from different regiments, or when in garrison, or when joined to a detachment composed of different corps, he takes precedence according to the rank given him in his brevet, or according to the date of any former commission; but while serving on courts-martial, or with a detachment composed only of his own regiment, he does duty and takes rank according to the date of his commission in that regiment. Brevet rank, therefore, is to be considered effectual for every military purpose in the army generally, but of no avail in the regiment to which the officer holding it belongs, unless it be wholly or in part united for a temporary purpose with some other corps. (See Samuel's 'Historical Account of the British Army,' p. 615.)

Something similar to the brevet rank above described must have existed in the French service under the old monarchy; for, according to Père Daniel (tom. ii. pp. 217 and 227), the colonel-general of the Swiss troops had the power of nominating subaltern officers to the rank of captains by a certificate, which enabled them to hold that rank without the regular commission. The same author states also that if any captain transferred himself from one regiment to another, whatever might be the date of his commission, he was placed at the bottom of the list in the regiment which he entered, without, however, losing his right of seniority when employed in a detachment composed of troops drawn from several different regiments.

The introduction of brevet rank into the British army, as well as that of the half-pay allowance to officers on retiring from regimental duty, probably took place soon after the revolution in 1688. But the practice of granting, when officers from different regiments are united for particular purposes, a nominal rank higher than that which is actually held, appears to have been of older date: for in the 'Soldier's Grammar,' which was written in the time of James I., it is stated that the lieutenants of colonels are captains by courtesy, and may sit in a court of war (court-martial) as junior captains of the regiments in which they command. (Grose, 'Military Antiquities,' vol. ii.) It was originally supposed that both officers holding commissions by brevet and those on half-pay were subject to military law; but, in 1748, when the inclusion of half-pay officers within the sphere of its control was objected to as an unnecessary extension of that law, the clause referring to them in the Mutiny Act was omitted, and it has never since been inserted. In 1786 it was decided in Parliament that brevet officers were subject to the Mutiny Act or Articles of War, but that half-pay officers were not. (Lord Woodhouselee, 'Essay on Military Law,' p. 112.) Brevet command, or rather local rank, a species of brevet rank extending only to a particular country during the continuance of war, was frequently conferred on officers during the Peninsular and Crimean wars.

BREVIA'RIUM was used among the Roman writers to denote a book introduced by Augustus, containing the accounts of the empire, the enumeration of the military, &c. (Sueton. 'Aug.' c. 28.) The design of this breviarium was to explain to the Roman people the manner in which the monies levied upon them were applied, not to the emperor's private use, but for public purposes. Tiberius laid aside the breviarium, but it was resumed by Caligula. (Sueton. 'Calig.' c. 16.)

BREVIA'RIUM ALARICIA'NUM is now the usual name of the code which was compiled at the command of Alaric II., king of the Visigoths, from the Roman law and the Roman jurists. It was completed A. D. 506, in the twenty-second year of his reign. The code was confirmed by the nobles and bishops, and signed by Anianus, the referendarius of Alaric; a circumstance from which the erroneous inference has sometimes been made that he was the compiler of it. The title Breviarium Alaricianum was only introduced in the 16th century; it was sometimes called Lex Romana, and sometimes Lex Theodosii, in respect of the most important part of its contents.

The contents of the Breviarium are formed of abbreviations or compilations from the following sources: 1. Codex Theodosianus, 16 books; 2. Novellæ of Theodosius II., Valentinianus III., Marcian, Majorian, Severus; 3. The Institutions of Gaius; 4. The Receptæ Sententiæ of Paulus; 5. Codex Gregòrianus; 6. Codex Hermogenianus; 7. Papinianus, lib. 1. Responsorum. Accordingly the code was composed of Imperial Constitutions, or Leges, as they are properly termed in the Breviarium, and of the writings of Roman jurists, which in the Breviarium are termed Jus.

This Code is of some value for the history of the Roman law, as it contains extracts from portions of the Roman law which are wholly or partially lost, as the work of Paulus, and from the first five books of the Theodosian Code, which however, owing to recent discoveries, are less imperfect than they were. The discovery of the Institutions of Gaius [GAIUS, P. C.] has rendered that part of the Breviarium in which Gaius was epitomised, of small value. The lacunæ in Gaius cannot be filled up from the Epitome, because the compiler paid little attention to retaining the words of the original, but the Epitome shows what matters were discussed in those parts of Gaius where the MS. is defective. The whole of the Breviarium is contained in the 'Jus Civile Antejustinianeum,' Berlin, 1815. For full information on this subject, the reader is referred to Savigny's celebrated work, 'Geschichte des Römischen Rechts im Mittelalter,' v. ii. c. 8; or to the French translation by Monsieur Guénoux, v. ii. c. 8.

BRE'VIARY, or canonical hours, the name of the daily service-book of the Church of Rome, consisting of the offices of matins, prime, third, sixth, nones, vespers, and the complines; that is, of seven hours, according with the saying of David, Ps. cxix. 164: "Seven times a day do I praise thee."

The origin of the name is variously accounted for: some deriving it from the little books of psalms and lessons read in the choir, collected out of large volumes, which the old monks carried with them in their journeys; others from the shortened service which was used in the papal palace of the Lateran, afterwards brought into general use. Grancolas, in his 'Commentarius Historicus in Romanum Breviarium,' 4to, Ven., 1734, says, "Breviarium dictum est quasi Breve Orarium, sive Precum Epitome;" an explanation countenanced by the circumstance that the name of breviary is not older than the year 1080, adopted after the offices which it contains had been revised and contracted.

In earlier times the designations of this service-book had been 'Horæ Canonicæ,' 'Opus Dei,' 'Divinum Officium,' 'Collecta,' 'Agenda,' 'Cursus,' &c. (Grancolas, *ut supr.*)

The Breviary originally contained only the Lord's Prayer and Psalms, to which were subsequently added lessons from the Scriptures. Various additions were afterwards made by the popes Damasus, Leo, Gelasius, Gregory the Great, Adrian I., Gregory III., and Gregory VII.; and in the progress of time, in compliance with the superstition of the day, the legendary lives of the saints were inserted, full of ill-attested and improbable facts. This gave occasion to many revisions and reformations of the Roman Breviary, particularly in the councils of Trent and Cologne, by popes Gregory IX., Nicholas III., Clement VII., Paul III., and Paul IV.; as likewise by some cardinals, and especially by Cardinal Quignon, who carried the reformation of it the farthest.

An additional reason for reforming the Breviary was found in the circumstance that different churches and orders of religious had their several offices, varying from each other, but still under the same name. Grancolas has separate chapters, de Ecclesiarum Orientalium Breviario —Distributio Officii apud Græcos—de veterum Occidentis Ecclesiarum, præcipue vero Mediolanensis Breviario—de Breviario Ecclesiarum Hispaniæ—Vetus Ecclesiæ Anglicanæ et Germanicæ Breviarium—de veteri Galliæ Ecclesiarum Breviario, præcipue vero Parisiensis—de Breviario Monastico, &c.

In England we have Breviaries more particularly appropriated to the cathedrals of York and Salisbury: an edition of the former, printed at York in 1526, is mentioned in Gough's 'British Topography;' editions of the latter, printed at Paris, occur in 1510 and 1536. The Breviary "in usum Sarum," was the service-book principally followed formerly in the English churches. But the variety of form, as already shown, was not confined to England; there was scarcely a church in the communion of Rome, in France, Flanders, Spain, Germany, &c., which had not something particular, however inconsiderable, in the form and manner of its Breviary.

Pope Pius V., who adopted the Breviary as decreed by the council of Trent, ordered all former Breviaries to be laid aside, by his rescript dated at Rome 7 id. July, 1568, whether made by bishops, orders of monks, or monasteries. Clement VIII., in another rescript dated 10th May, 1602, recognised Pius V.'s abolition of the Breviaries as used in different churches according to their particular forms of service, and confirmed the Breviary as fixed in 1568. Urban VIII. again confirmed it under a new revision 25th January, 1631. This last revision, by which the work was brought nearer to the simplicity of the primitive offices, is at present the Breviary of the Romish Church in general use. It was published in 1697, under the direction of Ferdinand de Bergem, bishop of Antwerp, entitled 'Breviarium Romanum, ex decreto Sacrosancti Concilii Tridentini restitutum, Pii V. Pont. Max. jussu editum et Clementis VIII. primùm, nunc denuo Urbani PP. VIII. autoritate recognitum,' fol. Antw. 1697.

The obligation of reading the Breviary every day, which at first was universal, was by degrees limited to the beneficed clergy alone, who are bound to do it on pain of being guilty of mortal sin, and of refunding their revenues in proportion to their delinquencies in discharging this duty. Some of the monastic orders have, with the consent of the pope, their peculiar Breviaries, but they contain no essential variations.

In addition to Grancolas's work already quoted, and the rescripts prefixed to the Breviarium of 1697, the reader may consult Koecherid's 'Bibliotheca Theologiæ Symbolicæ et Catecheticæ, itemque Liturgica,' 8vo, Guelpherb.,' 1751, pp. 747–768, where he will find a critical account of the editions of the Breviarium since 1549.

BREWING consists in the process of extracting a saccharine solution from grain, and in converting that solution into a fermented beverage called beer or ale. This art, although a perfectly chemical one in nearly all its stages, has not until very lately been indebted to chemistry for any of the improvements which have been made in its details; this we may attribute to the rare occurrence of a practical chemist being engaged in the operation of brewing. The great brewers, however, have lately made improvements in this matter.

This art is of great antiquity; for we find that the Germans, in the time of Tacitus, manufactured an intoxicating beverage from wheat and barley; and Herodotus (ii. 77), five centuries earlier, says that the Egyptians made a drink of barley. The Saxons also had various drinks of the same class; some made from grain, as *mum;* others from honey, as *metheglin;* but in Germany, in particular, they were early famed for their beer and ale. The towns of Lübeck and Rostock stood foremost in the list for their double beer or Brunswick mum, as it was called, at which places it was manufactured to an enormous extent: the latter town exporting, about the end of the 16th century, as much as 800,000 barrels. Heavy duties were, however, levied in this country on these imports, amounting at last, in the beginning of the reign of Queen Anne, to the enormous sum of 15*s.* per barrel. This heavy impost, together with the improvement in the breweries of this country, soon put a stop to the introduction of this article. Within the last half-century the manufacture of beer and ale has increased to an amazing extent both in England and in Ireland.

The process usually followed by the brewer of the present day may be divided into eight distinct parts, independent of the malting: namely, first, the *grinding* of the malt; secondly, the operation of

mashing; thirdly, the *boiling;* fourthly, the *cooling;* fifthly, the *fermentation;* sixthly, the *cleansing;* seventhly, the *racking* or *vatting;* and eighthly, the *fining* or *clearing.* In considering these various subjects, it will be better first to go over the processes in their order, and then return to the particulars of the principal processes, as respects the heat and precautionary details, &c. In brewing the various beers, as ale, porter, and table-beer, three distinct kinds of malt are employed; the pale and amber malts, the brown or blown malt, and the roasted or black malt. The first of these alone is used for ales; and for the finer qualities or higher priced, the malt is dried very pale indeed. This first quality of grain gives the saccharine extract; the second, or blown malt, gives the flavour to porters and stouts; and the last variety is used only as a colouring matter. The roasted malt is also sometimes called patent malt. [MALT.]

The grain being selected, it is ground either by millstones, or by allowing the malt to pass between two cylindrical iron rollers, placed horizontally at a certain distance from each other, with the space between them regulated by adjusting screws according to the size of the grist required. Many brewers prefer a fine grist (as the crushed malt is called); while others, on the contrary, consider that a greater extract can be obtained from a coarse one. Some use the millstones in preference to the rollers; others like the rollers best; others again employ both. In the last-named case, the brewer uses a circular sieve called a separator, through which the grist passes from the millstones; and only the grains that may have escaped this operation are carried to the rollers to be crushed.

The grist being thus prepared is now ready for the process of mashing. The mash-tun is usually of wood, varying in size according to the quantity of malt to be wetted, and having two or more holes called taps in the bottom. From one to two inches above this bottom is a false bottom pierced full of small holes, on which the ground malt is placed; the hot water is then admitted, and the grist is intimately mixed with the water. For this purpose it is either worked by machinery consisting of a horizontal axle supplied with vertical arms around its circumference, and these again having comb-like projections, the whole of which is made to traverse round the tun; or the *goods* (as the malt is now technically called) is worked up by means of instruments termed mashing oars, so as to cause the whole to assume a perfectly homogeneous consistence. This being completed, the whole is allowed to stand at rest for a certain time; the taps are then opened at the bottom of the mash tun, and the infusion or sweet wort is allowed to run off into a vessel called the underback, from whence it is pumped or otherwise conveyed to the copper for boiling. When the taps are spent they are closed, and a fresh quantity of hot water is run on for a second mash. Brewing coppers for small breweries are generally open; but in the large establishments dome coppers are employed, and on the dome of the copper a vessel is constructed called a pan, by which both time and fuel are materially economised; cold wort or water is placed in this vessel at the same time that the boiling is going on in the closed copper below, the steam from which is also driven into the pan, so that in the course of the time required for the wort to boil, the fluid in the pan is raised to the boiling temperature also. When the whole of the worts are pumped into the copper the hops are thrown in, and the boiling then commences. Large coppers are supplied with an apparatus called a rouser, consisting of a vertical rod of iron extending to the bottom of the copper, with chains pending from the horizontal arms which branch off from it, and which are dragged round the bottom by machinery so as to prevent the hops from settling down and burning. When the boiling is complete, the whole contents of the copper are turned into the hop back or jack back, which is a large vessel, having a false bottom for large brewings, and a sieve partition at the corners for small ones.

As the boiled worts drain from the hops, they are allowed to run into or are pumped into the coolers. These hops, when sufficiently drained, may be again boiled with a second copper of wort, or with the return wort or table-beer. The coolers are large shallow vessels, placed in as open a part of the brewery as possible, so as to command a free current of air over the whole of their surface: they may be constructed of either wood or iron. The latter possesses many advantages from its cleanliness, and the exposure of a large radiating surface to assist the cooling. Fans and blowers are sometimes used to assist the rapidity of this part of the process. The fans are placed in the middle of the cooler and whirl round, producing a considerable movement and current. The blower consists of a light iron paddle-wheel working within a box closed at all parts, except round the axle of the wheel, at which the cold air enters, and at the opening of the wooden pipe through which it is expelled. When sufficiently cool, the worts are allowed to run into the fermenting tun. As great injury may arise from the worts remaining too long in the coolers, more particularly in summer, it becomes necessary to employ artificial means of cooling by refrigerators, the principle of which is this: a current of cold water flows through a main in one direction, while the hot wort is made to traverse in the opposite, either in an inclosed pipe within the liquor main, or around the exterior of the cooling surface; the water becomes warm by cooling the wort.

The next operation, that of fermentation, is carried on in a vessel called a gyle, or fermenting tun, which is either of a square or round shape: the latter is preferable on account of the superior cleanliness.

As soon as the worts begin to run from the coolers, and when a sufficient quantity is in the tun, the yeast is added, being first rendered thin by some of the wort, so as to be easily miscible when thrown into the remainder. When the fermentation has arrived at a certain point of attenuation, that is, when a certain quantity of the saccharine matter of the wort has been converted into alcohol or spirit, it is to be cleansed from the yeast; and for this purpose it is either run into smaller vessels, such as casks or rounds, or the yeasty head is skimmed off from the top; and this is repeated at intervals until the beer is clean. This operation of skimming is generally confined to the cleansing of ales. The rounds or casks are simply filled with the fermenting beer, and so arranged as to be always kept quite full, with a trough or stillion to catch the yeast as it works out at the orifice of these vessels. Great care is taken to keep these casks clean. The beer, being thus cleansed from all the yeast, is now to be either racked directly into casks for ale, or run into vats prepared for it. In extensive breweries a large vessel termed a tank is first used, into which the beer intended to be vatted is allowed to run so as to be perfectly well mixed, and also to deposit a further portion of yeast by standing. The beer is by this means also rendered flat, which is necessary for stock or store beer that is to be kept some time before coming into use.

The last operation the beer has to undergo is the fining or clearing, which is sometimes done by the brewer, sometimes by the publican. The fining material consists of isinglass of various qualities, digested and dissolved in acid beer or sours. Its operation is supposed to be this: the gelatine or soluble matter of isinglass is more soluble in cold acid beer than in sound beer, water, or any fluid containing spirit; and therefore when the finings are added to a well-fermented beer, the gelatine is separated from the medium which held it in solution, and by its separation it agglutinates or collects together all the lighter floating matters which render the beer thick, and ultimately falls to the bottom of the vessel with them, leaving the beer clear and transparent.

The main thing to be observed in all the operations described is cleanliness, without which it is impossible that sound beer can be brewed, let the skill of the brewer be ever so great. The grist should be coarse cut, or, if crushed by rollers, should have the cuticle broken without destroying or breaking in pieces the grain; when this is done, the taps will spend more freely, and a fine bright wort will be obtained. For blown malt, very fine grinding is desirable; and the roasted malt may be ground as fine as possible, so that it will pass the stones or rollers without caking. The temperatures of the mashing liquors for ale or pale grists range from 170° F. to 185°; while for porter, where mixed grists are employed, the mashing heat ranges from 156° to 165°. The length of time for the worts to boil should be about an hour and a half, or until the worts break bright from the hops when a sample is taken from the copper. The proportion of hops to be used must depend so entirely on the beer in process of brewing, and the number of the boiled worts, that no certain rate can be laid down; but 4 lbs. of new hops per quarter of malt should be ample for present-use beers; for keeping-beers for exportation as much as 28 lbs. per quarter have been used, but this is the extreme limit. In fermentation, hardly any two brewers follow exactly the same routine, some using very low heats, others very high; some cleansing early, others late; some skimming off the head, others continually beating it in: these, with a variety of other operations adopted at various stages of the process, give rise to the great variety of different flavoured beers which we have in this country. The temperatures for fermentation range between 56° and 62°; not higher than 60° for ale worts, or above 62° for porter. The stages of a healthy fermentation are, first, a creamy scum rising on the surface: this, after a time, begins to curl and become frosted in appearance; it then becomes rocky, and the air vesicles which appeared frosted enlarge; it then passes to the size of small bladders, and after a short time the head begins to fall: it however rises again, becomes yeasty, the bladders enlarge in size, the yeastiness increases, and, when ready for cleansing, it has a vigorous, rich, yeasty brown and bladdery head. The yeast, after a time, will wear out and cease to ferment the worts healthily; under these circumstances a change must be procured, and at times one or two, before the desired effect will be produced. The yeast used in setting the fermentation should be about 2 lbs. per barrel; but this will vary with the strength of the beer, the extent of attenuation required, and the quantity of worts that are to be fermented together. Good malt and hops are of course indispensable in all these operations, and good materials are at all times more economical than inferior articles bought a few shillings cheaper; a greater extract is obtained, and a far superior article manufactured. Many persons imagine that the peculiarity of the water in different districts produces the recognised difference in the flavour of the beer brewed; but this is erroneous. Good beer may be brewed from hard or from soft water, whether obtained from a well or a river.

Such is a simple outline of the processes for brewing beer and ale. The reader will have no difficulty in conceiving that the mechanism and details of the processes must vary greatly, although the chemical principles may remain the same. In Bavaria the brewing of beer is one of the chief departments of manufacture; they have black beer, white beer, brown beer, thin beer, strong beer, double beer, bitter beer, &c., —differences which, in England, are expressed by various designations of ale, beer, porter, and stout. Bavarian beer and Scotch ale,

in a general way, differ from English beers and ales in being fermented at lower temperatures. Ale, in England, is brewed from paler malt than beer; porter is brewed from pale malt, coloured with burnt malt; stout is only a superior kind of porter; table-beer is simply poor or weak beer. Malt is the proper material for yielding beer; but imitative beers are brewed from bran, potatoes, spruce, sugar, and treacle. A few flavouring and sweetening ingredients are required and allowable in brewing; but much of the beer retailed in the public houses of London and other large towns is scandalously adulterated,—by the retailers rather than by the brewers, so far as is known. It has been ascertained, by chemical examination, that quassia, gentian, wormwood, broom-top are added to impart bitterness; capsicum, ginger, coriander, orange peel, carraway, to give pungency; opium, cocculus indicus, nux vomica, tobacco, poppy, henbane, to intoxicate; molasses, sugar, treacle, as substitutes for malt; sulphuric acid, alum, vitriol, salt, to impart various properties: some items in this numerous list are generally to be found. The Excise authorities have battled hard against these fraudulent dealings; but the subject is a difficult one to manage.

Much controversy arose in the metropolitan newspapers, a few years ago, concerning the price of London beer, which is as high when malt is cheap as when dear. The price has become, as it were, stereotyped. So attached are the inhabitants of the metropolis to this beverage, and so gigantic are the resources of the great porter breweries, that neither will the former abstain from porter because it is dear, nor will the latter lower the price. Any attempt to compete with the established houses in brewing porter (ale-brewing is subject to more competition) has hitherto failed; there are not more porter-breweries in the metropolis in 1859 than there were in 1839. This probably is due to the fact that most of the public-houses are more or less in the power of the brewers; while, on the other hand, new public-houses or beer-shops, unlike shops in other branches of trade, cannot be opened without magisterial sanction and licence. All these circumstances tend to restrict competition; and thus a gallon of porter costs one shilling when malt and hops are cheap as well as when double the price.

New inventions are occasionally patented in brewing, as in other departments of manufacture. Mr. Tizard, a brewer of Birmingham, has suggested a remarkable arrangement for fermenting the beer. He proposes the use of a subterranean fermenting room, to such a depth as to have a uniform temperature of 45° to 52° at all hours and seasons. This, in our country, would be at a depth of about 70 to 80 feet. The fermenting vessels are to be surrounded with cold water in this subterranean chamber. The cooled wort is to be conveyed by a pipe down into the vessel, and after the processes of fermenting, cleansing, and fining, it is to be drawn up again through racking taps, which only just dip below the surface of the liquid, so as not to disturb the lees of the liquor. This suggestion has, we believe, not been acted on. The same inventor, who is also the author of a Treatise on Brewing, patented in 1857 an apparatus for fermenting and cleansing beer: its principle is that of having a double cover, which rises and falls, and which holds within it either hot or cold water.

A cooler for brewing, introduced by Mr. Davidson, acts in the following way: the wort is pumped up at a slow and regulated speed into a recipient at the top of the machine; it there divides into a series of thin films or streams, and trickles down the inside of a number of thin metallic tubes, set vertically. An upward current of air passes through these tubes, meeting and cooling the hot wort.

The London porter breweries, adverted to in an earlier paragraph, are among the largest manufacturing establishments in this kingdom. The following refers to the statistics of Barclay and Perkins's brewery a few years ago; and as the quantity brewed by that firm annually is certainly not decreasing, the figures may supply a clue to the present scale of operations: About 100,000 gallons of water are required daily; two large steam-engines, of 45 and 30 horse-power, work the machines; there are 24 malt-bins, each as large as an ordinary three-storied house; more than 2000 quarters of malt are used per week; the great brewing-room is nearly as large as Westminster Hall; there are 10 brewing-coppers, each holding 12,000 gallons; the cooling-floor presents a surface of 10,000 square feet; there are 4 fermenting vessels, each of which will hold 1500 barrels of beer; the working-off of the yeast from the beer is effected in 300 vessels, containing 300 gallons each; there is a tank, for the reception of the beer at a certain stage in its progress, 120 feet long by 20 wide; the beer is stored in 150 large vats, of an *average* capacity of 30,000 gallons each; the largest vat contains 3000 barrels of 36 gallons, or 108,000 gallons in all, and weighs when full not less than 500 tons; the butts, puncheons, barrels, and other casks, in which the beer and ale are sent out to the retailers, are 60,000 in number; and lastly, 200 horses are employed to draw the drays in which the barrels are conveyed through the London streets.

Considered as a source of revenue, beer and ale have undergone some such changes as other articles of commerce. Beer was first made an exciseable article by the parliament in the 19th of Charles I., 1643. In December, 1660, persons by whom it was brewed for sale were required to pay an excise of 2*s.* 6*d.* per barrel on strong beer, and 6*d.* per barrel on small beer. In the following year the same duties were respectively imposed upon strong and small beer in Ireland; but beer brewed in Scotland was not chargeable with any duty until 1695, when the brewers paid 3*s.* 3*d.* per barrel on strong beer, 9*d.* per barrel

on small beer (to which rates the duties in England had been advanced in 1692), and 2*s.* per barrel on "twopenny ale." In 1697 the rates were increased in England and Scotland to 4*s.* 9*d.* on strong beer and 1*s.* 3*d.* on small beer. A further advance in 1710 carried the rates to 5*s.* and 1*s.* 4*d.* In 1761 the duties were fixed at 8*s.* per barrel on strong, 3*s.* on table beer, 1*s.* 4*d.* on small beer, and 3*s.* 4*d.* on twopenny ale. In 1802 the distinctions of small beer in England and Scotland, and of twopenny ale in the latter country, were no longer made, and the rates of duty were fixed at 10*s.* per barrel on strong, and 2*s.* per barrel on table beer, at which they were continued until October 1830, when the duty on all kinds of beer was wholly repealed. In July 1823, the legislature had sanctioned the sale of a quality of beer between the two kinds last mentioned, to which the appropriate name of "intermediate" beer was given, and upon this kind a duty of 5*s.* per barrel was payable, until 1830. The above-named rates were in addition to the duties charged in each division of the kingdom upon the materials of which beer is made. [HOPS; MALT.]

An attempt was made in 1806 to impose duty upon beer made in private houses; but this measure met with so much opposition, that it was abandoned by the chancellor of the exchequer, and the impost was confined, as it always had been, to beer brewed for sale by public brewers.

The quantities of "strong," "table," and "small" beer charged with duty in England, Scotland, Ireland, and Wales, between the years 1786 and 1830, never deviated far from 8,000,000 gallons per annum, yielding a revenue varying from 1,900,000*l.* to 3,500,000*l.*, according to the rates of duty charged. The duty on malt and hops is still retained, but the beer duty has been repealed. Very little foreign beer or ale is imported. British malt liquor is exported, but in a small ratio compared with the home consumption. In the three years ending with 1858, the average annual quantities were thus presented:—

To Australia	176,000	barrels
To the East Indies	133,000	„
To all other countries . . .	151,000	„
	460,000	„

BREZILIN. [BRAZIL WOOD, COLOURING MATTER OF.]

BRIBERY. [ELECTION.]

BRICKS. The small building materials obtained by moulding and drying, either with or without direct contact with fire, a plastic earth for the purpose of supplying the place of stones are called BRICKS, and their use seems to have been coeval with the earliest dawn of civilisation. We read, in fact, in Genesis xi. 3, and in the description of the building of the tower of Babel that bricks "burnt with fire" were even then known; and from Sir G. Wilkinson's work upon the 'Manners, &c. of the Egyptians,' 1st series, ii. pp. 96-99, it is evident that the art of preparing both the sun-dried and the kiln-burnt bricks was familiar to that nation. There are indeed still in existence both public and private buildings in Egypt erected with this material; and the recent discoveries of the ruins of Nimroud show that the Assyrians also were acquainted with its use. Herodotus mentions that in the construction of the walls of Babylon, bricks burnt in a furnace were employed; Xenophon also alludes to them; and Pausanias states that the walls of Mantinea were built of sun-dried bricks, if at least we may judge by the statement that when Agis was besieging the town, he destroyed the walls by turning the course of the river, so that it should wash away the walls of "crude bricks." The Romans, however, of the nations of antiquity seem to have used this class of materials the most habitually; and there are numerous and explicit allusions to the processes adopted in the manufacture in Columella, Varro, Palladius, Vitruvius, Pliny, &c. Wherever there was found to be any difficulty in procuring easily worked building stone, the Romans, in fact, resorted to the use of brick; and they even seem to have given it a species of general preference, for the majority of their great engineering works were executed with bricks, even when it was possible to obtain stone without any great additional outlay. The Roman bricks, however, were more like tiles, in the modern acceptation of the word, than those made at the present day; and, as we shall have occasion to observe, their use rendered necessary the adoption of a style of construction rather different from that of ordinary modern brickwork.

During the early part of the middle ages bricks were little used, and it would even appear that it was not until about the 11th and 12th centuries, that their manufacture was revived in Northern Italy, and in the Rhenish and Flemish provinces. From thence the use of bricks seems to have spread rapidly, until about the 16th century, when it almost universally superseded the use of stone, in countries even wherein the latter material was easily and economically obtained; perhaps in consequence of the absurd fiscal regulations of the times. Of late years the fashion has changed, and bricks are only used when there are local conditions of so imperative a nature as to render it inexpedient to employ the more costly, but more beautiful material. In every country, however, where fuel is cheap, and large deposits of plastic clay are to be found, bricks are almost exclusive employed, on account of their economy, and of the ease with which they are laid. The nature of the fuel, and still more the nature of the clay used, so materially affects the dimensions, and the details of the manufacture of bricks, that it will be impossible to notice all their varieties; it is therefore proposed simply to describe the more general known descriptions made for the London market, under the various heads of walling bricks, paving bricks or clinkers, and fire bricks.

Ordinary walling bricks may, for convenience sake, be considered first, under the classification of "kiln-burnt" bricks, or "clamp-burnt" bricks, according to the method of their burning; or they may be considered under that of *malms* or *common* bricks, according to the nature of the clay which enters into their composition. The various-coloured bricks, red, white, blue, and black, are obtained from clays of peculiar descriptions, to which attention will incidentally be called in the sequel.

Kiln-burnt bricks are, as their name implies, those which are burnt in kilns; a method usually adopted when fuel is expensive, and the clay is sufficiently stiff and strong to require to be treated like pottery clay. The clays, in fact, which contain a large proportion of carbonate of lime are liable to fuse in the furnace, if exposed to great heat; and, therefore, the bricks made from them require to be burnt in kilns, wherein the heat may be regulated at will. The operation of kiln-burning is slower also than that of clamp-burning, and for this reason especially it is not resorted to in the neighbourhood of London, where the demand is so enormous. The bricks which are burnt in kilns are usually of a better and more uniform colour, and of a more regular form than those burnt in clamps; but they are not usually so well vitrified, nor are their powers of resisting atmospheric influences by any means equal to those of bricks burnt at higher temperatures. Moulded bricks, tiles, and drain-pipes, and in fact, all earthenware, of which it may be desired to retain the particular form impressed by the moulder, are invariably burnt in kilns.

The kilns may be either closed or open, though there can be no doubt as to the superiority of the former system. The closed kilns are made to receive about 24,000, or even 30,000 bricks at a time; but the dimensions usually adopted are to make the chamber for stacking the bricks 10 feet wide, 20 feet long, and about 13 feet 6 inches in clear of the arch. The open kilns receive from 40,000 to 50,000 bricks at the same time; and occasionally in Holland, they are even made large enough to receive three millions at once. In the latter case, however, the advantages of kiln-burning are entirely lost, so far at least as the influence of the burning upon the quality of the goods is concerned.

Clamp-burnt bricks are usually composed of a clay which is fusible with so much difficulty as to require that the fuel should even be mixed in the body of the brick itself; and it thus happens that, from the intimate manner in which the heat penetrates the whole mass, the bricks burnt in clamps are more thoroughly burnt, and consequently are of a more durable nature, than those prepared in kilns. The clamps, however (which are, in fact, only stacks of dried bricks with occasional layers of fuel interspersed), are exposed to great irregularities in the manner in which the combustion takes place; and the quality of the bricks varies sensibly according to the manner in which the combustion has so taken place. Where the fire has been too powerful the bricks run into a species of semi-vitrified state, and are known as clinkers; where the fire has not been powerful enough, the bricks are soft and incoherent, and in this state they are known amongst the London workmen under the names of *grizzles*, or of *place* bricks. The latter phrase, it must be observed, is applied also to the soft kiln-burnt bricks. Clamps are usually made to consist of 500,000 bricks; but very often as many as a million are burnt in one stack; the loss by fracture, clinkering, and underburning is hardly ever less than 10 per cent.

Malm bricks are those which present a warm buff colour, and a close uniform grain, when pains have been taken in their manufacture. They are usually made from the fine clays of the post tertiary periods, in which there is a considerable quantity of the carbonate of lime diffused through the mass in a highly comminuted state, or even occasionally in chemical combination. Where this diffusion does not exist naturally, it is imitated by adding chalk in the necessary proportions; and thence arises the subclassification of the *natural* and *artificial* malms. Great care is required in burning all the descriptions of malm bricks to exclude the ordinary atmosphere from them during the operation of burning; and on this account as well as on that of the chemical nature of the clay, malms are always burnt in kilns. It is also extremely important that no large masses of the carbonate of lime should exist in the bricks; for during the process of burning, the lime would naturally pass into the caustic state; and as this caustic lime eventually would absorb moisture from the air, it would expand, and disintegrate the body of the bricks. It has even happened that walls built of bricks made from clay containing a large proportion of carbonate of lime have swelled bodily, when erected in such positions as to be able to absorb moisture. The best malm bricks are made near Ware, in Hertfordshire; Erith, in Kent: the Suffolk bricks are also, in fact, a species of malms, but they usually are white, from the fact of their possessing an excess of the carbonate of lime in the composition of their clay. Indeed as the calcareous marls, from which malms are made, vary in their composition so much, that the carbonate of lime may be either 14 or 46 per cent. of the whole mass, the colour of the bricks may vary in as distinctly marked a manner. The quantity of oxide of iron present in calcareous marls also varies within a very wide range; or between 2 and 6½ per cent.

Common bricks are made from the coarser descriptions of clays, and the latter are generally so stiff as to require to be mixed with certain proportions of sand, or of coal ashes, to ensure their plasticity. The clay is dug, and exposed to the weather in small pieces, called, near London, *curfs*, in order, as the workmen say, "to mellow," and it is then mixed with the sand or ashes in such a manner as to ensure the equal distribution of those ingredients. This operation is called *soiling*, and it is succeeded by the *tempering*, which is effected by turning over the clay by hand, and subsequently by passing it through the pug-mill, previously to its being carried to the moulder's *stool*. It is true that most of these operations are required to be performed in the preparation of all kinds of bricks; but the preparation and previous manipulation of common clays require to be effected with more care than is necessary with the clays of a superior quality.

The common bricks are invariably burnt in clamps in England and in Belgium. In England the products are classed, according to their quality, either as *cutters*, or the fine grained rather soft bricks used for cutting ornamental work; *picked stocks*, of a bright uniform colour; *paviours*, or the hardest and most regular bricks, fitted for the purpose indicated by their name; *common stocks*, *grizzles*, *burrs* or *clinkers*. Many of these names are applied to the differently coloured bricks before referred to, and it may suffice here to say that the red, blue, or black colours in question result from the variable proportions of the hydrous oxide of iron in the clays, and they change as the clays themselves may be affected by the degree of heat to which the bricks are exposed.

Paving bricks are made from clays containing silica, in a form which would allow of its passing into a state of semi-fusion, and thus of producing a hard imperishable material. The best paving bricks are made from the mud of the Yssel in the Netherlands, and they are known in commerce under the name of Dutch clinkers; very good materials of this description are, however, made at Uppingham from the clays of the lower oolite; or in the neighbourhood of Birmingham, from the clays of the carboniferous series.

Fire bricks are those which are used in positions where they are required to resist the direct action of fire, and they must, therefore, be of an infusible nature. This term is, however, only to be used relatively; that is to say, it must be understood that the danger of fusibility will vary in every different description of furnace, and the bricks required to resist the heat of an engine furnace will be exposed to a heat which will be far less than that of a porcelain kiln. Whatever be the degree of heat to be resisted, the general characteristics of the clay fitted for fire-bricks are that it should be as free as possible from any mixture of lime, magnesia, or iron; and that the silica should be present in the soluble form. The best fire-bricks are made at Stourbridge, but articles of nearly equal value are made at Edinburgh, Newcastle, Glasgow, South Wales, and latterly the peculiar beds of the subcretaceous formations near Farnham, in Surrey, have been worked for the purpose of making fire goods of a very peculiar nature. Great pains are required to be taken in preparing the clay for fire-bricks, in order to avoid any unequal contractions or expansions; and it is essential that the bricks should be exposed, whilst in the kilns, to a greater degree of heat than they are likely to be called upon to resist subsequently. Fire-bricks are all moulded by hand, and kiln-burnt.

Dr. Richardson gives the following analyses of some of the fire-clays of Newcastle, which may be referred to as illustrating some of the extreme varieties of this class of materials.

Numbers	1.	2.	3.	4.	5.	6.	7.
Silica . . .	51·10	47·55	48·55	51·11	71·28	83·29	69·25
Alumina . .	31·35	29·50	30·25	30·40	17·75	8·10	17·90
Oxide of iron . .	4·63	9·13	4·06	4·91	2·43	1·88	2·97
Lime . . .	1·46	1·34	1·66	1·76			
Magnesia . . .	1·54	0·71	1·91	trace	2·30	2·99	1·30
Water and organic matter . .	10·47	12·01	10·67	12·29	6·94	3·64	7·58

The dimensions of bricks vary, as was said before, not only on account of the quality of the clay from which they are made, but also in many cases on account of the fiscal or excise laws of the locality. Upon the Continent bricks are usually made about $8\frac{2}{3}$ inches in length, by $4\frac{1}{3}$ inches wide, and $2\frac{1}{6}$ inches thick; but in consequence of the old excise laws of our own country the dimensions of English bricks are almost invariably 9 inches in length, by $4\frac{1}{2}$ inches wide, and $2\frac{7}{10}$ inches thick. The ancient Romans, and even the modern Italians, have adopted very different dimensions from either of the above; for in their buildings bricks are occasionally to be found having a length of 30 inches, by a width of 9 inches, and a thickness of $2\frac{3}{5}$ inches; and in the old Roman wall of London itself the bricks were $17\frac{1}{2} \times 11\frac{3}{4} \times 1\frac{1}{4}$. The Austrian bricks are often $12 \times 6 \times 2\frac{1}{2}$; the old *Reuzen* bricks of Friesland were made $13 \times 6\frac{1}{2} \times 3\frac{1}{4}$; whilst the ordinary Dutch *waal steen* are $7\frac{3}{4} \times 3\frac{3}{4} \times 1\frac{3}{4}$. In fact, every imaginable proportion and dimensions have been adopted; but the principles which ought to regulate them are, firstly, that they should not be such as to interfere with the proper degree of burning; and, secondly, that they should be such as that a working man could easily handle the bricks without undue fatigue; consistently with these conditions, the larger the bricks are, the better and more economical will they be, both in manufacture and in use.

In laying bricks, the most important precautions to be observed are, that the cementitious material should be equally and carefully applied, and that the joints of the bricks should never be immediately over one another; or, to use the workmen's phrase, the bricks "must break bond." There are two descriptions of bond commonly adopted in England, which are known under the respective names of the *Flemish* and the *English bond*, about the relative merits of which there is a great diversity of opinion. The Flemish bond is made by laying the bricks in a course, alternately lengthwise or across the line of the wall, as stretchers and headers; the English bond is made by laying all the bricks in one course as headers, and all those of the course immediately above it as stretchers; but in both cases care is taken that no vertical joint shall be carried through two consecutive courses, and that the face of the wall shall be carried up vertically, or in regular batter, when the face is not perpendicular. The large bricks of the Romans were, however, used under rather different conditions from those prevailing in modern buildings; for they were in fact used as bonding-courses in the midst of a large body of rubble masonry, in the majority of cases, and therefore they did not require the same minute attention to the arrangement of the joints which is necessary when the mass of a wall is composed solely of small, regular-shaped materials. When the Romans used bricks exclusively, they seem to have adopted rather what we should call the old English, than the Flemish bond. In many of the Roman brick arches, bricks radiating to the centre have been used; and indeed that wonderful people was evidently as well acquainted with the art of making moulded earthenware as are the best manufacturers of our own days. It would appear, also, that their engineers were aware of the fact that the strength of brickwork depends more upon the mortar used in its preparation, than it does upon the resistance of the bricks themselves; for they paid great attention to the composition and to the manipulation of their mortars, as we shall have occasion to remark in detail, in the articles CEMENT, LIME. In the middle ages, it may be added, the use of bricks took place under nearly the same conditions as in earlier periods, so far as the mode of placing them in the work is concerned; but the architects of Northern Italy and Germany obtained new and striking effects of colour by the use of moulded and glazed bricks; whilst in France and in parts of England architectural decorations were obtained by cutting the bricks themselves. The bricks which admitted this treatment were of course the fine grained, uniform, and rather soft bricks; but when proper precautions have been observed in placing them, time and exposure have produced far less effect upon their surfaces than might have been expected.

As the quality of bricks varies within so wide a range, and, as we said before, the quality of the cementitious material used with them limits the practical strength of this description of work, it may be dangerous to attempt to lay down any absolute rules with respect to the resistance brickwork can offer. Mr. Edwin Clark, however, in the course of his experiments at the Menai Tubular Bridge, ascertained that the average resistance of brick-work, set in Roman cement, to an *instantaneous* effort of compression, was equal to about 33·5 tons upon the superficial foot; and in the great St. Rollox chimney, near Glasgow, the weight actually brought upon the lower courses of brick-work is nearly 16 tons 14 cwt. per foot. In the trials to which some of the brick viaducts of the Havre and Rouen line of railway were exposed, after the fall of the Barentin Viaduct, the crushing weight thrown upon the piers of brick-work, set in ordinary chalk-lime mortar, was made equal to about 6·4 tons on the superficial foot; but at the time this trial was thought to be exaggerated, even though no accident ensued from it. M. Vicat carried on, some years since, a series of experiments on the subject of the strength of brick-work; and from them it would appear, that the instantaneous and the safe permanent resistances, per superficial inch, according to the nature of the mortar employed, may be considered to be as follows:—

	Instantaneous.	Permanent.
Chalk lime and common sand, fourteen years old .	270 lbs.	81 lbs.
Ordinary hydraulic lime " " .	1050 "	315 "
Eminently hydraulic lime " " .	2043 "	613 "

These values are high; but if care be taken in the execution of the work, they may be adopted as maxima. M. Vicat also made experiments upon the resistance of similar materials to an effort of extension, and he deduced from them the following table:—

	Instantaneous.	Permanent.
Chalk lime and common sand, as before . . .	57 lbs.	17 lbs.
Ordinary hydraulic lime	129 "	39 "
Eminently hydraulic	213 "	64 "

The resistance to an effort of torsion is usually considered to be equal to about $\frac{5}{8}$ of the resistance to compression.

A very important practical observation, with respect to the use of bricks in foundation works, is, that the under-burnt bricks are more easily acted upon by external agents, such as water containing carbonic acid gas in solution, than are either the unburnt clay or the thoroughly burnt bricks. It follows, therefore, that in such positions only the hardest and most perfectly burnt bricks should be used, especially if

the water attacking the foundations should be frequently changed; but if the water should be stagnant, it may happen, when the bricks contain a large proportion of soluble silica, that the free lime of the mortar may form with it a stable combination which will greatly increase the strength of the mass. This peculiar action is known amongst working men by the phrase of the brick-work being "water bound;" and it may be observed to occur when rather soft kiln-burnt bricks have been used in permanently damp ground, in connection with rich lime mortar. In tidal works, however, or in positions where the water is frequently renewed, none but the hardest bricks and the most energetic cements should be used; and this precaution must always be adopted in those parts of a building exposed to alternations of dryness or of humidity.

Brick-work, in the neighbourhood of London, is reckoned at so much per rod, or the unit of bricklaying accounts is the rod of 272 feet superficial, of work 14 inches thick; that is to say, of 11⅓ cubic yards, or 306 cubic feet. Assuming that the bricks are laid with a close joint, to a gauge of four courses to 11½ inches in height, there will be required 4500 stocks and 71 cubic feet of mortar in a rod. The weight of a cubic foot of brick-work in cement is about 105 lbs., and that of a cubic foot of brick-work in mortar is about 98 lbs. In most tables of specific gravities, that of brick-work is quoted as being 1·87; but this is rather in excess of the real facts of the case.

Brickmaking by Machinery. We must now attend to those remarkable modifications of the processes which have been due to the introduction of machinery. Rapidity of production is not the only reason for the adoption of machines. It has been found in some of the brickwork of railway arches and tunnels that the outer or most exposed bricks have a tendency to decay, from the alternations of temperature and moisture to which they are subjected; and it is as a means of lessening that tendency, by increasing the solidity and closeness in the adhesion of the clay of which the bricks are formed, that machine-made bricks have often been recommended.

About 1836 Messrs. Heaton of Birmingham, who had before introduced a mode of tempering the brick-clay by rolling, devised a machine for moulding the bricks as well as preparing the clay. The machine consisted of a horizontal wheel, round the margin of which were arranged a number of brass moulds, the proper size and shape for bricks. The bottom of each mould was loose and moveable vertically by a small apparatus beneath, connected with a little wheel. The wheels of all the moulds worked on a circular railway, having such an inclination as to leave the bottom of the mould in its proper position when at one part of the circular course, but lifting it up to the top of the mould when the latter had travelled round half a circle. When any of the moulds came to a particular part of the circuit, a loose board was put into it by an attendant, a stream of water was forced into it from a forcing pump, and the tempered clay, coming from the rollers through which it had been pressed, and passing through a hopper, was forced by a plunger into the mould; then, the mould advancing one step in its circuit, a knife-edge sliced off all the superfluous clay, and rendered the upper surface smooth. The mould continued to travel on in its circular path, and its bottom, with the newly-made brick, became lifted up gradually; until, by the time the half-circuit had been made, the brick was lifted wholly out of the mould: a man then took off the brick, and prepared it for burning in the usual manner. It was a necessary feature in this arrangement, that all the moulds were in different states or stages at any one instant of time; half of them contained bricks, half contained none; one was just receiving its supply of clay, while another, exactly opposite, was yielding a finished brick to the hands of the workman; and of the rest, some were having the loose bottoms slowly raised to elevate the bricks resting on them, while others were gradually resuming the form fitted for the reception of clay.

In 1838 M. Terrason introduced a mode of making bricks differing considerably from the above. There are three parts of the apparatus, destined respectively to kneading the clay, moulding the bricks, and transporting them when made to a yard or depository. In the first process, two horses, attached to the two arms of a lever, work some revolving cutters in a cylinder, by which the clay is thoroughly kneaded. The second machine, destined to mould the bricks, is placed near the former one, and receives the fillet of clay as it exudes from the cylinder. The mould for the bricks is simply an oblong channel or hollow frame, having neither cover nor bottom, but one roller working above it and another below it. The clay enters this trough, the width and height of which give the proper width and thickness of a brick; while the two rollers, pressing the clay above and below as it enters, give the proper flatness of form to the upper and lower surfaces, compress the clay into a solid consistency, and expel the superfluous portions. The clay, in fact, passes through a kind of rolling-press. When the oblong trough has been removed, by reciprocating action given to it by machinery, from this press, the board on which the clay rests becomes released from the side-boards of the trough; then on passing under a particular part of the apparatus, the oblong fillet of clay is cut into ten or twelve bricks, by the descent of as many wires stretched across above them. In the third machine, by means of a long row of cylinders working on an inclined plane, the board of bricks is carried to any convenient distance, where they are deposited previous to burning.

In the same year another machine was invented by Mr. Jones, in

which the clay, being mixed with a less quantity of water than usual, was kneaded in a pug-mill to a stiffer consistence than ordinary, thereby rendering a shorter period for drying sufficient. The rate at which the bricks were made by this machine was stated to be from one to two thousand per hour.

From about the year 1840 the suggested or patented improvements in brick-making have been very numerous; but they do not call for lengthened description. In Mr. M'Nab's method there is a sliding-frame beneath the bottom of the mill in which the clay is ground; and this frame contains two brick-moulds, so arranged that while one of them is under an opening in the bottom of the mill, receiving clay from thence, the other is outside the mill delivering a moulded brick; the two moulds being alternately placed in communication with the mill. The bottom of each mould consists of a moveable bed, which, when the mould has arrived outside the mill by the movement of the frame, forces the brick up out of the mould, to be removed by an attendant. Another method introduced about the same time, had a peculiar adjustment whereby a screw forces the clay out of the mould, and wires descend to cut it into bricks. A method patented by Messrs. Cook and Cunningham is on a different principle. Here a sliding mould-frame, containing two moulds, is applied to the side of the mill in which the clay is prepared. The clay is forced, by the rotation of arms within the mill, through an opening into a box; and a piston working in this box presses the clay into one of the moulds in the sliding frame. When one of the moulds has been thus filled, the frame moves forward, which brings the other mould under the box, while the first mould is carried over an empty moveable mould placed on a table; a piston presses the brick into the empty mould, and the mould thus set free returns to receive a fresh supply from the box. The mode is thus so far a continuous one—that while one mould is emptying its contents into the moveable one, the other is receiving a fresh supply at the box; while a boy receives the moulded bricks from the moveable mould as fast as they are deposited in it. Mr. White's patent, of the same year, related principally to an improvement in the mode of supplying the clay from the mill.

Mr. Gibbs has proposed a method in which both the materials of the bricks and the mode of manufacture are taken into account. He proposes to use Merstham sand or pulverised Merstham sandstone, combined with London clay or pipe-clay; in proportions varying according as bricks, tiles, or pottery are the object of manufacture. The mode of making bricks under the patent embraces two or three modifications, of which one consists in rolling the clay out into a sheet of uniform thickness, then cutting it by machine-worked knives or wires into brick-shaped pieces, and compressing these by a separate machine. An American method introduced more recently by Messrs. Beach and Lukens, seems to be founded mainly on the plan of Messrs. Heaton, but to contain a provision for transporting the bricks to any convenient spot by means of an endless belt.

Mr. Prosser has introduced a method of making bricks, tiles, and small articles of earthenware, from earth or clay almost in a state of dryness, by intense pressure in metallic moulds.

The *weight* of bricks, made by any method, is an important matter in relation to the purpose for which they are to be applied. In a conversation at the Institute of Civil Engineers, after the reading of a paper relating to bricks, several engineers objected to the use of bricks made wholly by machinery, on the ground that their extreme compactness made them heavier and more costly than common bricks, and delayed their drying. Mr. Hunt has, for this reason, brought into use a contrivance where hand-power and slight pressure are substituted for machine-power and heavy pressure. The decision as to the general introduction or not of machine-made bricks, will probably depend, as in most other cases, on the relative expense in comparison with the hand method; hitherto they have been rather too costly. At Roorkee, in the north-west of India, where extensive engineering works have been carried on, requiring a hundred million of bricks, great economy has been found to result from the introduction of a brick-making machine from England.

It may be well to notice one peculiar manufactured article, which receives the name of a brick from its shape, and not from its use or purpose. A manufacture peculiar to, and constituting a staple trade of Bridgewater, is the fabrication of that kind of white brick known as *Bath Brick*, so largely used in knife-cleaning; this branch of industry gives employment to many of the inhabitants. These bricks are formed of the sediment or sand of the river Parret, cast into moulds and dried.

Bricks, like many other articles of manufacture, underwent many varieties in the rate of duty imposed. The tax was first laid in 1784, at 2*s.* 6*d.* per thousand. In 1794 it became 4*s.*, and in 1803, 5*s.* In 1835 the duty was increased to 5*s.* 10*d.*, for common bricks of ordinary size. In 1803, bricks of larger size were taxed to the extent of 10*s.* per thousand. Polished bricks were 12*s.* 10*d.*, and large polished 24*s.* 2*d.* The words of the Act referring to glazed bricks were "smoothed and polished;" and so strict were the revenue officers, that bricks struck with a bat or on a table to straighten them if warped, were considered to be "smoothed and polished," and were charged with the extra duty. At length, in 1850, this vexatious duty was removed; and a beneficial result was almost immediately perceived, by allowing scope for the exercise of inventive talent. The maker, under the old law, had no

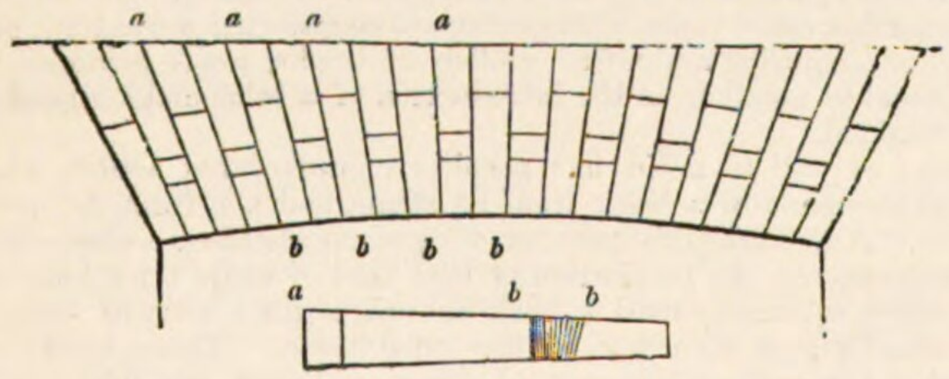
encouragement to depart from the ordinary size and quality; seeing that the duty rapidly increased if the bricks were either larger in size or uperior in quality. Just before the duty was repealed, it was charged on about 2000 million bricks annually; there are now no means of determining how many are made.

BRICKWORK. Brick walls are of various thicknesses; from four and a half inches to three or four feet, according to the nature and purpose of the structure. The most usual dimensions are four and a half inches or half brick; nine inches or one brick; fourteen inches or one and a half brick; and eighteen inches or two bricks. Except in large public works, walls are seldom built more than four bricks thick. In good work three bricks are well bonded together.

The word *bond* is applied to the mode of laying bricks side by side, and one on another, so as to produce the greatest strength, and the most symmetrical appearance. There are four kinds of bond—besides exceptional kinds which need not be noticed here—in general use in laying bricks; called English bond, Flemish bond, herring bond, and garden-wall bond. *English bond* consists of bricks laid lengthwise on the length of the wall, and crossed by bricks laid with their breadth on the wall. The former are called stretching courses, and the bricks stretchers; the latter are heading courses, and the bricks headers. This bond is much used in hydraulic engineering. *Flemish bond* consists in laying a header and stretcher alternately in the same course. This bond, which is considered by bricklayers the most beautiful, is not so effectual as the English bond. To unite more firmly the Flemish bond brickwork, especially in thick walls, and to remedy the weakness of the stretching courses, the bricks are often placed at an angle of forty-five degrees parallel to each other, and reversed in the alternate courses; this is done in the centre or core of thick walls, and is called *herring-bond*. It is advisable only to use this diagonal brickwork occasionally; because, though the bricks in the core have sufficient bond, the sides, on occount of the triangular interstices, are very improperly tied to the core. Flemish bond is, moreover, varied according to the width of the openings in the wall or front of a house. The reveals of windows are bonded every alternate course, with a closure or quarter brick and a half brick. The reveals of doors are terminated with a half brick and closure. *Garden-wall bond* consists of three stretchers and one header in nine-inch walls; but when fourteen inches thick, the Flemish bond is used. In English bond, it is to be observed, that as the length of a brick is nine inches, and its breadth four and a half, it is the practice to prevent two perpendicular joints from falling over each other, at the end of the first stretcher from the corner header, by the introduction of a closure, or by a three-quarter brick or *bat* as it is technically called, instead of a stretcher at the corner.

The most difficult work for the bricklayer to execute is the groining or intersection of arches in vaults, where every brick has to be cut to a different bed or angle. This and the arches called gauged arches, either circular or straight, cut with the axe and rubbed on the banker or table, and afterwards set in lime only, called putty, require the neatest workmanship. Some straight arches are made roughly; that is, the bricks are inclined each way, parallel to each other on the respective skewbacks or shoulders of the arch, until the soffit-ends of the bricks touch, when the vacant space at top is filled with two bricks forming a wedge: this arch, like other straight arches, is constructed on a camber slip, or piece of wood slightly curved on the upper side, and serving as a centering.

The bricks for rubbed or gauged arches are cut with radiating lines. Those for cambered or straight arches are cut by the manual skill of the workman; and the lines do not radiate exactly to one centre, like the bricks in semicircular gauged arches. The following is the method adopted by bricklayers in cutting the straight arch: The straight arch, so common in houses in London, is first drawn out the



Mould.

[Cut of the mould with the bevels set off upon it.]

a represents the point at the top line of the mould, being a guide for the brick; *b b*, the angles set off by the bevel.

full size on a board; the top part is a straight line; the lower, the curved line of the camber-slip, a segment of a circle; and the sides, the inclination of the skewback of the arch, which is usually inclined about seven inches and a half from the upright of the reveal. The top and the bottom lines are then divided into an equal number of equal parts, and lines radiating are drawn as shown in the cut. The joints follow the curve of the camber-slip. The curved line at the bottom given by the camber-slip is cut by means of the bevel; every

angle of each brick being different, they are copied by the bevel, and set off in succession on the mould and numbered, so that for the rest of the operation, the workman has only recourse to the mould.

A larger, or what is called an irregular, segment is cut in the same manner. A semicircular arch being struck from one centre requires but one mould, without the aid of the bevel, as all the bricks are alike and have their ends at the same angle. All arches, it should be observed, are constructed on centerings of wood. In straight arches the camber-slip answers the purpose of a centering. Elliptical arches are cut like straight and semicircular arches, the ends like semicircular arches, and the centre like camber arches. Corbelling, or a projecting of brickwork, is often practised to gain space for flues and over corners of narrow streets.

In steyning wells it is usual to employ brickwork where the soil is loose. For this purpose a centre is required, made with circular rings of wood boarded round the outside; upon these rings the bricks are laid. As the digger excavates the ground, the centre with the brickwork sinks and another is laid upon it till the whole work is completed.

Mortar is the common medium employed in the execution of brickwork. This mortar, in the neighbourhood of London, is composed of lime, gray or white, but gray or stone lime is the better; it is mixed with river sand, sea sand, or road sand, in the proportion of one of gray lime to two and a half of sand, and one of white or chalk lime to two of sand. In dry weather and for firm work the best mortar should be used, and the bricks should be wetted or dipped in water as they are laid, which makes them adhere firmly to the mortar. Brick-work in drains and foundations, where it is liable to be constantly wetted, becomes so firmly united with the mortar as not to be separated without the greatest difficulty.

In building walls, they should be carried up level all round simultaneously, and not one part higher than another, lest in the shrinking there should be a settlement, which would cause the parts to separate. In laying the foundation of walls the first courses are always laid broader than the wall intended to be carried up; these courses are called the footings; and the projections, called set-offs, are generally two inches in projection. Garden-walls are usually built with piers, projecting four and a-half inches from the face of the work at every ten or twelve feet. These piers are turned in at the top like buttress-heads, and the top of the wall is finished with a course of brickwork on edge.

When new walls are to be attached to old it is usual to cut a chase or draw a brick at every other course in the old work and *tooth in* the new work. When it is intended to add walls to other buildings these toothings are left. The flues for chimneys are twisted to prevent their smoking; they are always chalked on the wall of a house to which another is intended to be added.

A rod of brickwork was originally taken from the standard of $16\frac{1}{2}$ feet square, and consequently consisted of $272\frac{1}{4}$ square feet; but as the $\frac{1}{4}$ was found troublesome in calculation, 272 superficial feet has been adopted as the standard for a rod of brickwork. The following is the method in practice for calculating the number of rods and feet in a brick wall, if of the standard thickness, which is $13\frac{1}{2}$ inches, or a brick and a half. Multiply the length by the height, and divide by 272, which will give the rods; if it is more or less than the standard thickness, multiply the surface by the number of half-lengths of bricks in the thickness of the wall, divide the product by 3, and the wall will be reduced to the standard, which, if divided by 272, will give the work in rods: or if the work is cubed, it must be divided by 306 to reduce it to rods, &c. A rod of standard brickwork set with mortar will require 4500 bricks upon an average: the mortar required for the same is $1\frac{1}{2}$ cwt. of chalk or white lime with two loads of sand, or 1 cwt. of stone lime with $2\frac{1}{2}$ loads of sand. In walls a foot of reduced brickwork requires 17 bricks. A foot superficial of gauged arches requires 10 bricks. A yard of paving requires 82 paving bricks, or 48 stock bricks, or 144 Dutch clinkers laid on edge, or 36 bricks laid flat. The weight of a rod of brickwork is calculated to be 15 tons 7 cwts. 2 qrs. 1 lb., in the following quantities:—

	tons.	cwts.	qrs.	lbs.
4500 bricks	9	18	0	9
81 cubic feet of sand . .	3	8	3	20
40 ft. 6 in. of chalk lime . .	2	0	2	0
	15	7	2	1

Among the most remarkable specimens of ancient brickwork are the masses on the Palatine hill and the baths of Caracalla. The Roman brickwork in large works is excellent: the bricks are very hard, and so firmly cemented, that they cannot be separated without the greatest difficulty. Great care has been shown in the execution of the work; and one building, still existing near the grotto of Egeria, has pilasters, cornices, modillions, dentils, and other ornaments finely cut in a yellowish brick closely cemented together and still in high preservation. The most recent specimens of ancient Roman brickwork are the walls which surround Rome: there are also many specimens scattered throughout Italy. The bricks being generally thin and of the nature of tiles, this circumstance diminished the difficulty of constructing arches, of which the great arches of the Temple of Peace in the Forum Romanum are remarkable examples. The Tauk Kesra at

Ctesiphon (about 18 or 20 miles from Bagdad) is perhaps the largest ancient brick arch existing, being a semicircle 85 feet wide, 106 feet high, and 150 feet long.

The worst bonded specimens of brickwork executed by the Romans are those formed of triangular bricks filled with rubble. The reticulated work, which is constructed with stones, is often bonded with courses of brickwork. In Pompeii columns constructed with bricks have been discovered: in this city the brickwork of the public buildings has been very accurately executed.

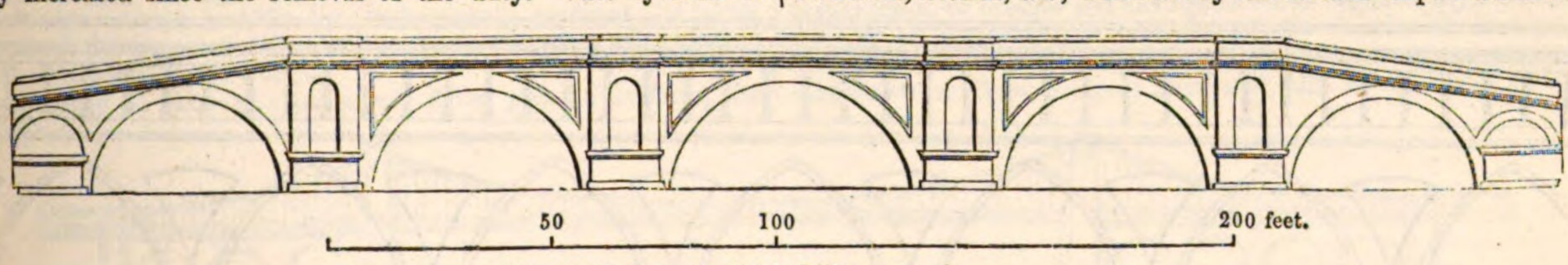
The brick dome of Santa Sophia at Constantinople is made of porous bricks, light enough to float on water. The brick towers of Bologna are stupendous piles of brickwork. The brickwork in Holland is very accurate. There are many curious brick fronts in Germany, especially in Hanover, and some architectural display in brickwork appears in several of the smaller Italian towns. But the most singular and beautiful brickwork is found in North Prussia, in the Marien Kirche at Brandenburg, the castle of the Teutonic knights, and a variety of other buildings.

Brickwork was not common in London until after the great fire of 1666. There are early specimens of brickwork in some of the old baronial mansions, in which the chimneys are the most conspicuous features. But few of these houses are of greater antiquity than the time of Henry VII. and VIII.; and most of them date about the reign of Elizabeth. Hampton Court, built by Cardinal Wolsey, is a specimen of good ancient English brickwork. One of the most elaborately carved specimens of English brickwork with which we are acquainted is a tomb in the church of Wymondham, Norfolk, which is in the early Italian style, covered with grotesque ornaments. The practice of carving cornices, &c., in brick continued till about a century ago, when it ceased, owing to the more frequent use of stone. Inigo Jones used brick-moulded cornices in some of his structures.

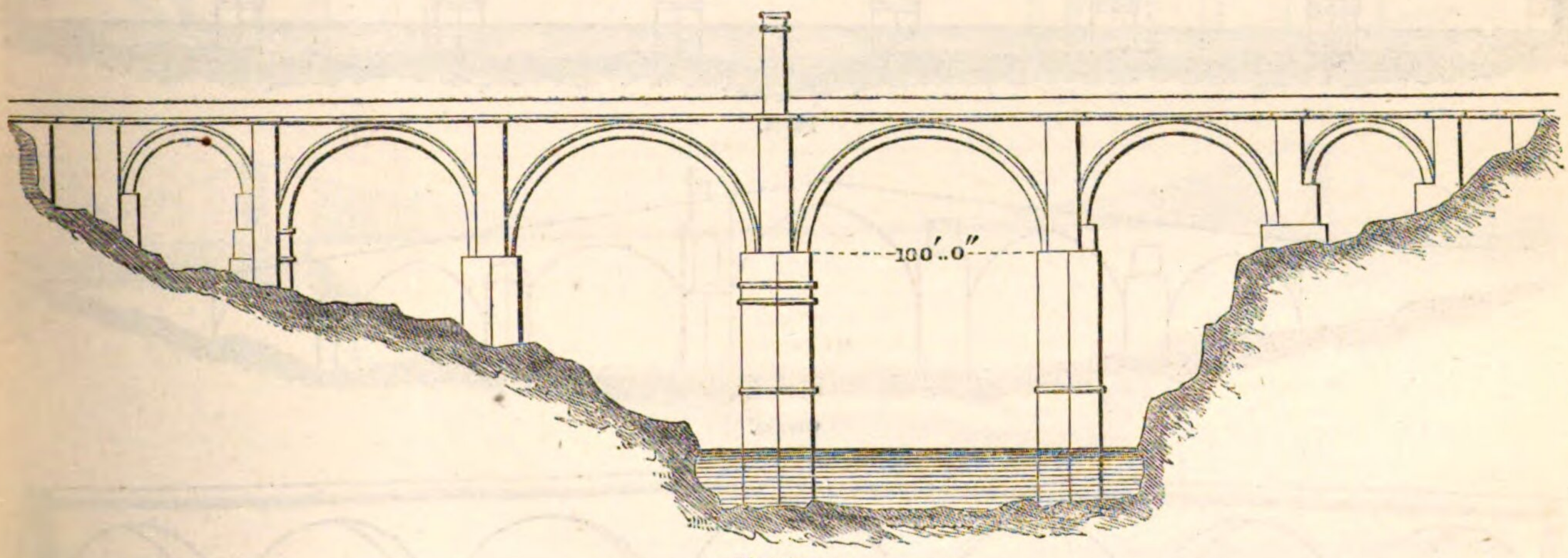
It may safely be asserted that London now contains more brick structures than any other city in the world—so abundant is the supply of clay, and so distant are the quarries of stone. As a general rule, the private houses do not display any great excellence in brickwork; perhaps St. James's Square, and a portion of the buildings at Kensington Palace, are among the best. Several of the vast warehouses recently built in New Cannon Street present fine examples of brickwork, dressed with stone. Many of the new churches exhibit a careful use of red, yellow, and white bricks—the manufacture of which has greatly increased since the removal of the duty. Vast systems of brickwork are comprised in the sewers of London; and still finer examples will probably be afforded by the great intercepting drainage now (1859) just commencing. The Thames Tunnel is a large and fine specimen of brickwork. Still more extensive are the viaducts of brick arches belonging to the various railways which enter the metropolis. The very perfection of brickwork, probably, is exhibited in the lofty factory chimneys, some of them 400 feet high, in Lancashire, Cheshire, Yorkshire, and around Glasgow.

BRIDGE. A construction by means of which a roadway or a footpath is carried across a river, or other piece of water. In common language bridges differ from aqueducts, insomuch as the latter convey water only; and from viaducts, because viaducts usually are erected in deep valleys wherein the watercourse occupies but a very small portion of the space traversed, whereas bridges are essentially erected in the watercourses it is desired to pass.

Although unquestionably the necessity for erecting some means of permanent communication between the respective banks of large rivers, must have been felt at an early period in the history of civilised nations, it was not until a comparatively late one that the art of bridge building can be said to have assumed any definite character. The Greek historians, indeed, mention the erection of very important bridges by Semiramis, Darius, Xerxes, Pyrrhus; and in Egypt, the irrigation canals must have rendered it necessary to construct many such passages. But it would appear that the style adopted in all these constructions was of the rudest and most unscientific character; and, in fact, it consisted simply in the erection of piers upon the tops of which were laid horizontal beams of timber, or large flat stones. During the monarchy and the early days of the republic of Rome, bridge building remained in this rudimentary state; and even subsequently to the completion of the Cloaca Maxima, wherein the principle of the arch is boldly and successfully applied, the earliest of the bridges over the Tiber was constructed of timber as above described. This would be the more singular if, as has been asserted, Tarquinius Priscus, during whose reign the cloacæ were made, actually built a stone bridge over the Teverone; but inasmuch as there are reasons for doubting the correctness of this story, it would be safer to consider that the erection of the first stone bridge of large span, was that of the Ponte Rotto, or the Senator's Bridge, built about the year 127 B.C., by Caius Flavius Scipio. This was rapidly followed by other works of the same description, such as the Ponte Mole, Janiculum, Fabricius, Sestius, &c.; and directly the Roman empire was definitely



Pons Senatorius, now Ponte Ritto, restored.



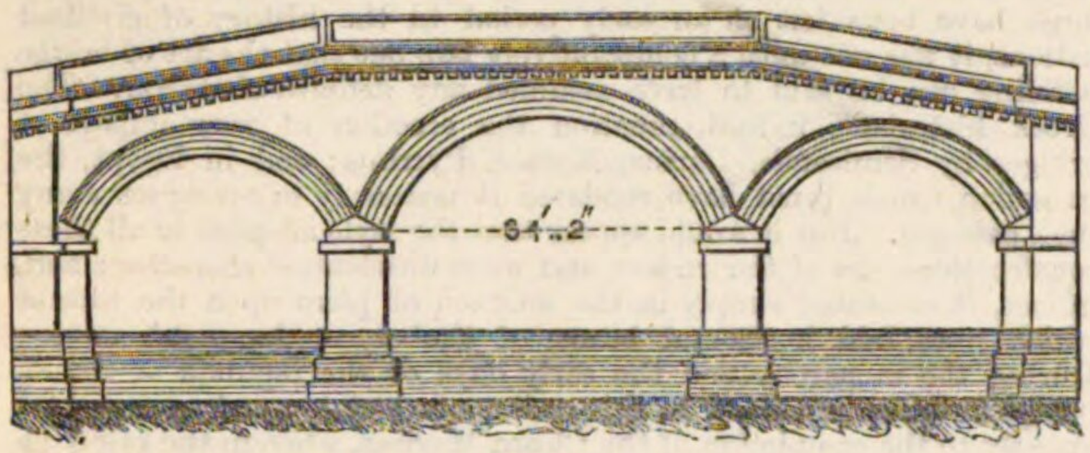
Alcantara.

established under Augustus Cæsar, the series of wonderful engineering works connected with the formation of roads, and the establishment of water supplies, which still challenge our admiration, were commenced. In fact, arched construction was essentially a Roman invention; and it was not until their civilisation had distinctly developed itself that the art of bridge building could be said to exist. It is true, however, that the Assyrians and Egyptians had applied the principle of the arch long before Rome exhibited any indications of its future greatness, as has been shown under ARCH, vol. i. col. 486.

It has been asserted that the Chinese have, for countless ages, possessed many of the arts and sciences which Europeans have only acquired within a few years and after a tedious and painful series of experiments. Amongst the rest, it is said, that the art of bridge building was practised amongst them, at periods long antecedent to its cultivation in the West; and the bridges at Fou-tcheou-fou and at Suen-tcheou-fou are quoted amongst their earliest works of this description. There are no reliable accounts of these structures, but from the little which can be gathered from the travels of the Jesuit missionaries it would seem that the Chinese, at the time of their erection, were not able to execute great bridges in a superior style to that adopted by the Egyptians, Assyrians, or Greeks; for those above-named were simply formed by laying large horizontal stones upon upright piers. It is true that in China, bridges are said to exist in which pointed, semicircular, polygonal, and semi-elliptical arches are

to be found; but the date of these works is unknown; and from the very equivocal character of the chronology of the East, there must always prevail a degree of uncertainty with respect to the authenticity of the claims of those nations to extreme antiquity. Without therefore deciding upon the question of the claims of the Chinese to the discovery of the art of bridge building, we may content ourselves by asserting that it is to the Romans that Europeans owe that useful art, and that the models they left have served as starting points to the efforts of modern engineers.

Indeed during the more prosperous days of the Roman empire, the attention of the central administration was directed, with singular energy and perseverance, to the perfection of the means of internal communication: and the making of roads, of which the construction of bridges formed a necessary part, was carried to a very remarkable degree of perfection. The bridges of Rome itself have been already alluded to; but although numerous, and it may be added bold in

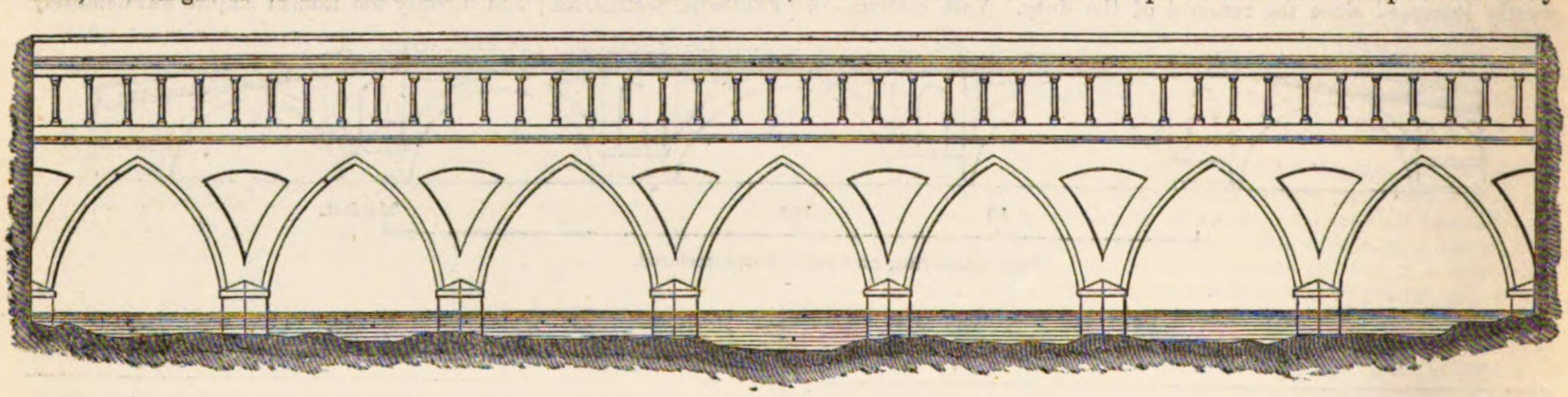


Vicenza.

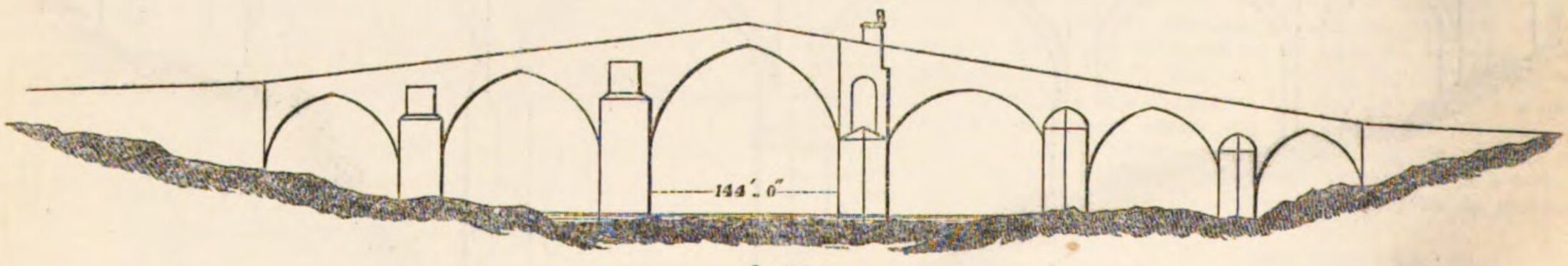
their design and execution, they fell much behind the bridges erected in the provinces in both those qualities. Thus the bridge of Narni had a centre arch with a chord or span of not less than 131 feet; and the span of the centre arch of the bridge of Alcantara is 101 feet: but the bridge erected by Trajan over the Danube was the master-piece of Roman engineering of this particular description. It consisted of 20 semicircular arches of 180 feet 5 inches span, springing from piers 64 feet wide on the line of the axis, by 85 feet 3 inches thick, at a height of 46 feet above the water-line of the river in its

normal state. Unfortunately the later emperors were not able to carry on the vigorous policy of Trajan, and the bridge he had thus built at so great an expense to enable his own armies to attack the barbarians of Dacia, was so soon made use of by the Dacians themselves to attack the Roman dominions, that Adrian thought it advisable to destroy the glorious work of his predecessor. In France, Spain, Italy, Greece, Asia Minor, and even in Northern Africa, however, the Roman bridges have been fortunate enough in many instances to escape the ravages of time and of war; and the bridges of Vicenza, Boisseron, Sommiers, St. Chamas, &c., may still be referred to as illustrating the practical and æsthetical feeling of the Roman architects in designing such works.

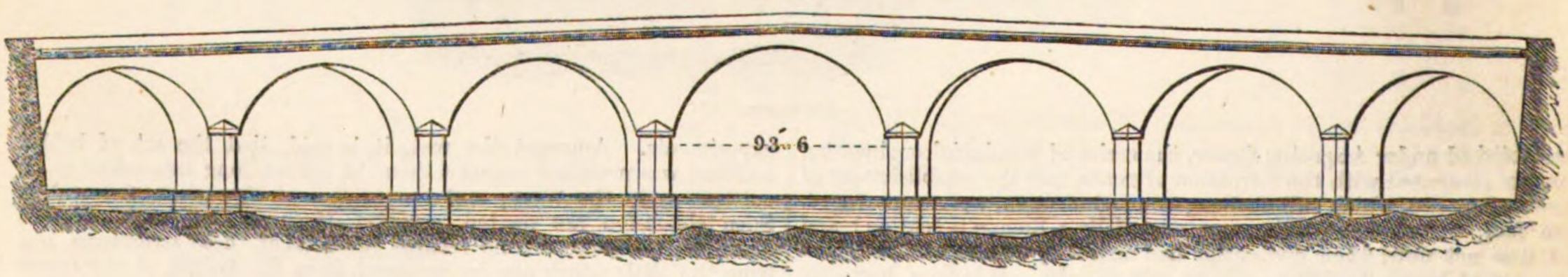
During the stormy interval between the periods of ancient and modern history, the art of bridge-building shared the fate of the other material expressions of civilisation. It was occasionally practised, both by the architects of the Lower Empire, and by the more refined of the conquerors of Rome; indeed, some of the bridges of the time of Justinian, such as the aqueducts near Constantinople, or the restoration of the Ponte Salaro, were nearly as striking works of their kind as were the provincial bridges of the earlier Roman emperors. The extraordinary aqueduct of Spoletto has been usually attributed to Theodoric the Goth, who reigned, however, about the commencement of the 6th, instead of about the middle of the 8th century, to which latter period the construction of this aqueduct has been assigned; with about as much correctness, be it observed, as in the case of its author, for the style of architecture adopted in it certainly did not prevail until about 500 years later than its supposed erection. Whatever were the date of the Spoletto aqueduct, there are no authentic records of the erection of stone or brick bridges of any kind subsequent to the time of Charlemagne until about the commencement of the 11th century, when the order of the Frères Pontiers, or du Pont, was established, for the express purpose of remedying the defective state of the modes of communication, arising from the want of new bridges or the destruction of the ancient ones. The Pont St. Esprit over the Rhone, the bridges of Ratisbonne and of Avignon, were amongst the earliest works due to the efforts of this useful association; or, perhaps, as the authenticity of the existence of the separate order has been questioned, it would be more correct to attribute the execution of these bridges to the civilising influence of the Church in the middle ages. Slowly the civil authorities of western Europe followed the example set them by



Pavia.



Orense.



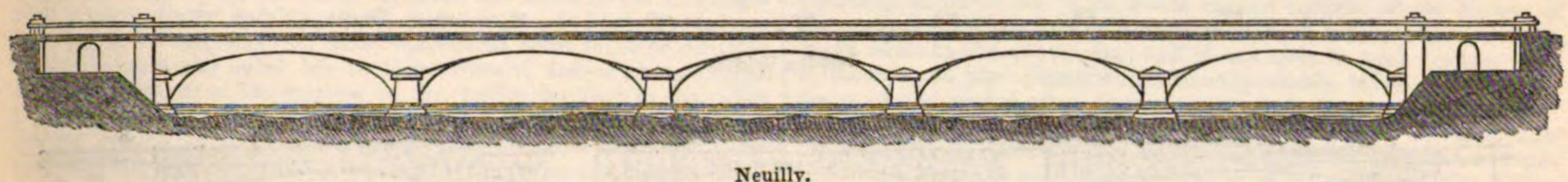
Ponte Corvo.

the Churchmen; and we read of the erection of the old bridge at Bow, by the orders of Matilda, the wife of the Conqueror; of old London Bridge, about 1176; the old Bridge of Dresden, the Biddeford Bridge, and the singular triangular Bridge of Croyland, being erected in connexion with many analogous works about the 12th and 13th centuries. The covered bridge over the Ticino at Pavia, and the long causeway and bridge of Orense in Galicia, Spain, are amongst the most remarkable structures of the middle ages; and they were worthily followed by the Ponte Corvo, over the Melza; the Pont Notre Dame, at Paris; the covered and the marble bridges of Florence; the Rialto of Venice;

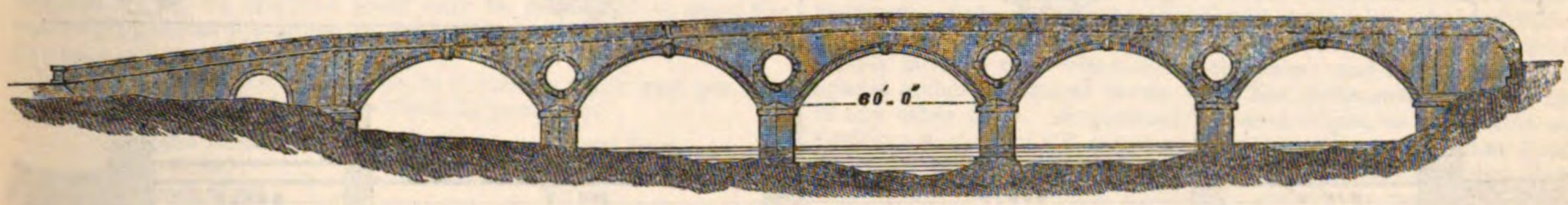
the Ponte della Trinita, also of Florence; the Pont Neuf, of Paris; the bridges of Saintes, Maestricht, and des Tuileries. About the commence-

Ponte della Trinita.

ment of the 18th century, however, the greatest movement in the art of construction, as applied to the means of intercommunication, seems to have taken place; and the establishment of the corps of the Ponts et Chaussées in France, about 1720, must be considered to have given a more scientific and organised direction to the study of the engineering profession, especially in that country to which all Europe then looked for instruction and example. The bridges of Blois, Orleans, Tours, Mohlins, and Saumur, were amongst the first works produced by the above-named body of engineers; and they were followed in rapid succession by the very beautiful structures erected by Peyronnet at Neuilly, St. Maxence, and the Pont de la Concorde, at Paris. Our own countrymen were not far behind their neighbours in the erection of these useful structures; and the bridges of Blenheim, Westminster, Blackfriars, Perth, Coldstream, Hexham, Kelso, &c., may fairly be compared with any similar works of France, or of any other country. But the



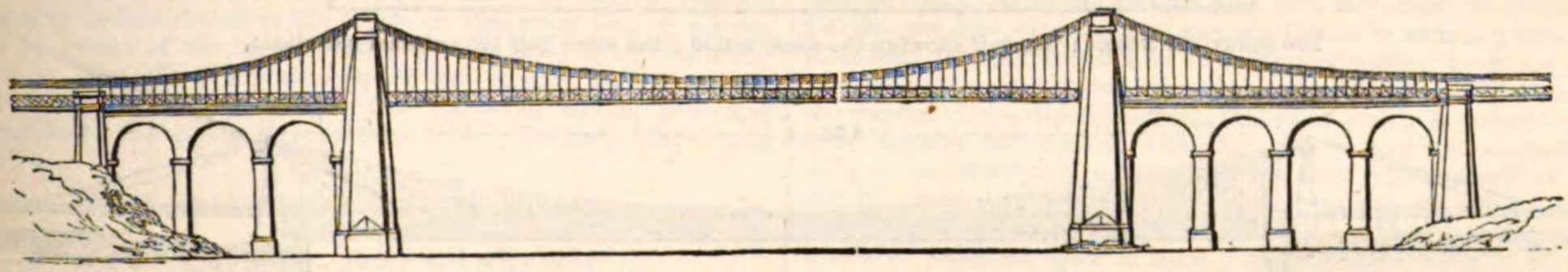
Neuilly.



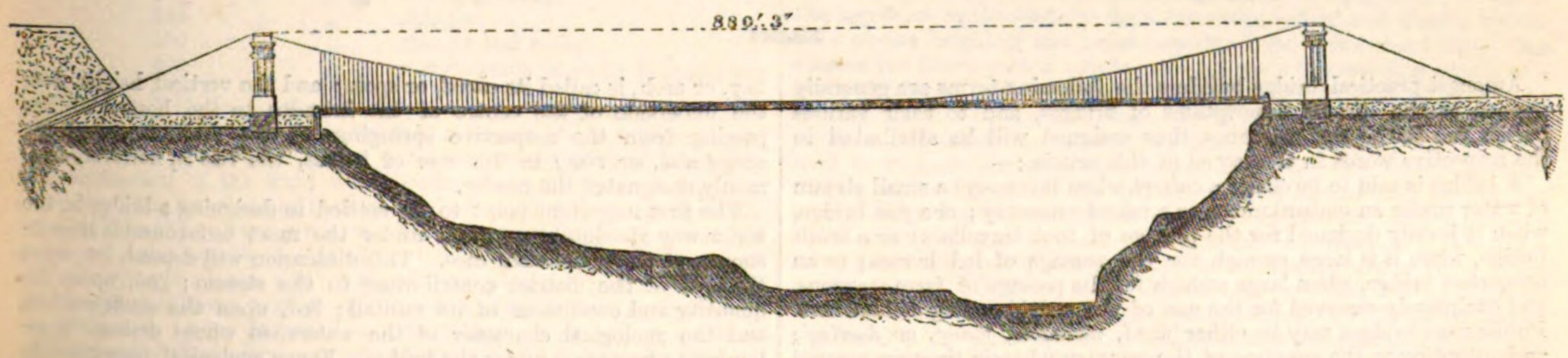
Coldstream.

introduction of cast iron amongst the ordinary building-materials of bridges, by Mr. Pritchard of Shrewsbury, about the year 1775, in the erection of the Coalbrookdale Bridge, laid the foundation of a new and singularly valuable style of construction. The example set by Mr. Pritchard was followed by Thomas Wilson, at Sunderland, in 1795; and shortly afterwards cast-iron was largely applied, both in bridges and in aqueducts, by Telford and his contemporaries in England. The German and Swiss engineers of the 18th century executed some remarkable specimens of carpentry, and some stone bridges of considerable dimensions. Amongst the former may be mentioned the Schaffhausen Bridge, erected in 1770, by Grubenmann; amongst the latter, the Dresden, Nossen, and Nürnberg bridges; attention will be called hereafter to some of these works.

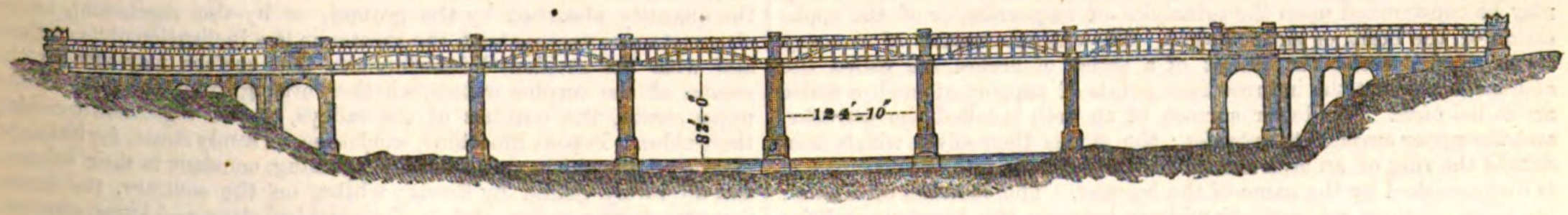
Subsequently to the commencement of the present century, the wonderful progress of civilisation (promoted by the improvements effected in the means of locomotion; firstly, by the introduction of carriage-springs, by the development of the canal system, by the application of steam to navigation, and finally by the execution of the railways which now intersect every part of Europe) has caused the art of bridge-building to advance with a rapidity hitherto unexampled. In proportion also with the improvement of the art itself, it would appear that the requirements of public authorities have increased; and thus the genius and skill of the engineers (as the members of the architectural profession who especially directed their attention to the construction of bridges and analogous works began to style themselves, by way of distinction) were taxed to the utmost. It was to these facilities for local communications that we owe the introduction of the suspension or chain-bridges; later still, the wrought-iron girder and



Menai.



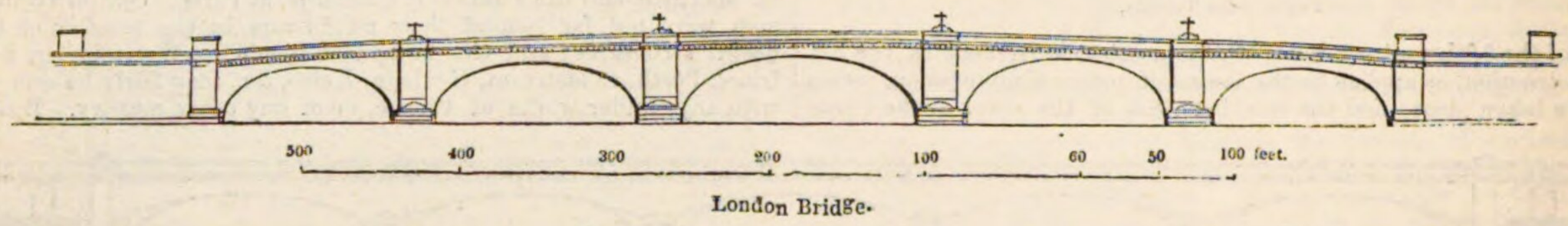
Fribourg.



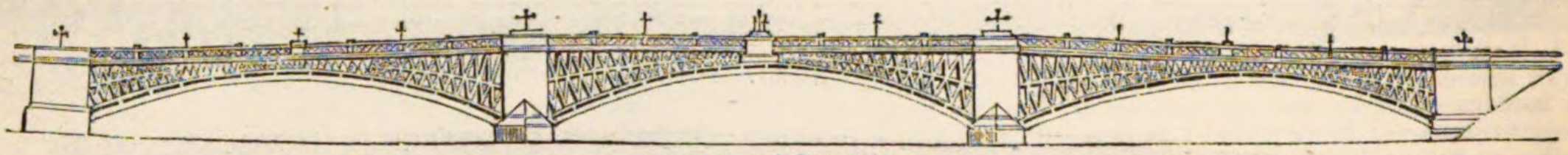
Newcastle High Level.

tubular bridges; and the lattice bridges, whether of wood or of iron, have also been invented to satisfy the constantly increasing requirements of the age. Many of the bridges erected in the course of this century are as remarkable as works of art as they are as works of construction; and it may suffice here to mention, in our own country, the Gloucester, Dean's Bridge Viaduct, Lune Aqueduct, Llangollen and Pont-y-Cysylte Aqueducts, London and Waterloo stone bridges, Southwark iron bridge, Menai, Hammersmith, Hungerford, and Pimlico suspension bridges, the High-Level Bridge, the Britannia, Conway, and Saltash tubular bridges, to illustrate the progress of the art. Amongst our neighbours, also, a

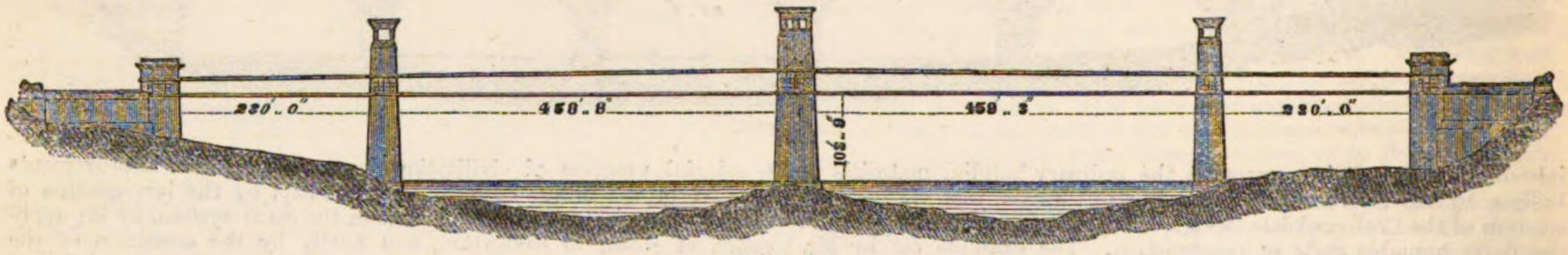
similar activity may be observed to have taken place as among ourselves; and the gigantic works executed in France, Belgium, Germany, Switzerland, Italy, and even in Spain, within the last few years, prove that those nations are as deeply impressed with the necessity for providing at almost any cost the means of easy and uninterrupted locomotion, which is indeed the end bridges are designed to subserve. The inhabitants of the United States have not been behind in this race of improvement, and we owe to them several of the boldest innovations in the art of bridge-building, to which they have been driven by the peculiar conditions of their country. The Bridge of Trenton over the Delaware, the Upper and Lower Schuylkill bridges near Philadelphia, the great Portage Viaduct, and the Niagara Suspension Bridge may challenge comparison with any similar works erected in Europe.



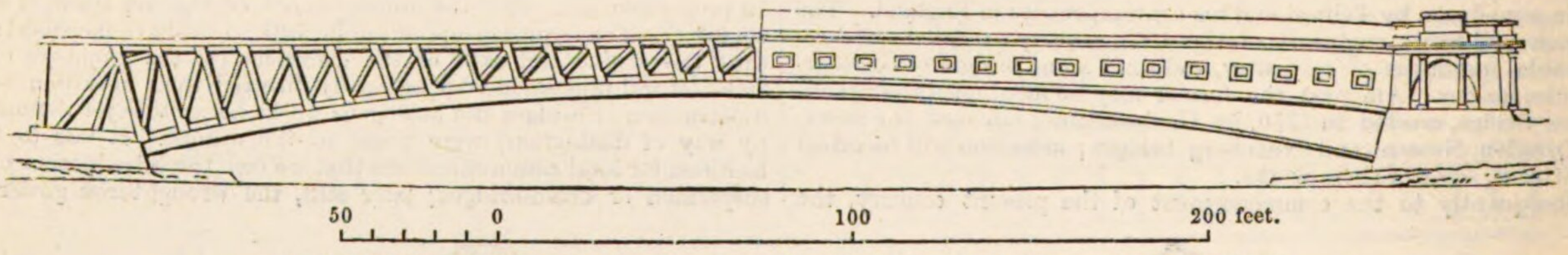
London Bridge.



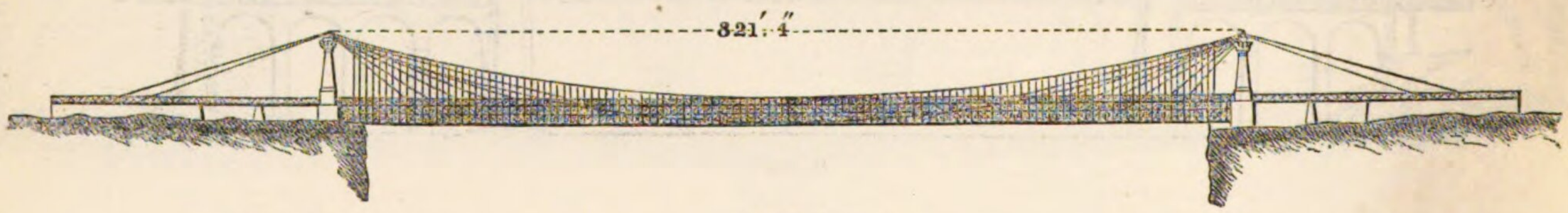
Southwark Iron Bridge.



Britannia.



The Schuylkill Bridge: one half showing the construction; the other half the external elevations.



Niagara

Amongst practical bridge builders the following terms are generally applied to the various descriptions of bridges, and to their various parts; and the several meanings thus assigned will be attributed to the respective words in the sequel of this article :—

A bridge is said to be either a *culvert*, when it conveys a small stream of water under an embankment, or a raised causeway; or a *foot* bridge, when it is only designed for the passage of foot travellers; or a *bridle* bridge, when it is large enough for the passage of led horses; or an *occupation* bridge, when large enough for the passage of farm waggons, and exclusively reserved for the use of the neighbouring landowners. Public road bridges may be either *fixed*, *moveable*, *flying*, or *floating*; and according to the resource of the country wherein they are erected they may be constructed of stone, brick, wood, or iron; or again they may be constructed upon the principles of *suspension*, or of the application of the built, or girder beams. The extreme masses of masonry constructed to resist the thrust of a series of arches, are called the *abutments*; whilst the intermediate points of support of such a series are called *piers*. The lower surface of an arch is called the *intrados*, and the upper surface its *extrados*; the stones themselves which constitute the ring of an arch are called the *voussoirs*, and the central one is distinguished by the name of the *keystone*. The *haunches* of an arch are those portions respectively midway between the keystone and the *springing*, or *skewback*; and the filling in above the arch, to the underside of the roadway, is called the *spandril*, or the *spandril filling*, as it may be upon the face, or in the interior of the work. The construction between two piers, or between any two points of support, is called an *arch* in stone, brick, or cast-iron bridges; but a *bay*, in timber or wrought-iron ones. The distance between the points of support of a bay, or arch, is called its *chord*, or *span*; and the vertical height from the underside of the centre of the intrados to the horizontal line passing from the respective springings of the arch, is called the *versed sine*, or *rise*; in the case of beams, the rise is, however, commonly designated the *camber*.

The first important point to be settled in designing a bridge is, the water way absolutely required under the most unfavourable circumstances of the particular case. This dimension will depend, 1st, upon the area of the district contributing to the stream; 2nd, upon the quantity and conditions of its rainfall; 3rd, upon the configuration, and the geological character of the watershed whose drainage is intended to be passed under the bridge. Every geological formation, in fact, parts with the excess of the rain which may fall upon it (beyond the quantity absorbed by the ground, or by the vegetation), under circumstances varying with the greater or less inclination of its surface, and with the accidental interferences that surface may offer to the escape of the surplus waters, whether arising from the state of the upper strata, the outlines of the valleys, or the vegetation covering their sides. Porous limestone, sandstone, or sandy strata, for instance, yield streams which are, generally speaking, constant in their volume, and are rarely visited by floods; whilst, on the contrary, the dense, non-absorbent granites, slate rocks, marbles, clays, and loams, give rise to streams which are notoriously capricious in their flow, and liable to serious and unexpected floods. It is, moreover, to be observed that the denser and non-absorbent formations usually occur in mountain chains, at considerable elevations above the sea level, and that their outlines are sharp and precipitate; whilst those of the absorbent strata are for the most part gently undulated. It thence happens that

not only is the rainfall upon the former more copious than that upon the latter, but that it runs off with greater rapidity. From this it also follows, that the water way to be given to bridges in districts composed of the non-absorbent strata, must be made greater than that which would suffice for the porous ones. M. de Belgrand, in an article inserted in the 'Annales des Ponts et Chaussées,' stated that the granitic rocks, being usually the most precipitous, were those which required bridges with the largest water way; but that with an equality of fall, the liasic formations required nearly the same, if not rather larger, dimensions; the clays, whether of the secondary, or post-tertiary series, were considered by him to require bridges somewhat smaller; whilst the oolites and the chalk admitted the construction of bridges with comparatively speaking small water-ways. It is observed, however, by M. de Belgrand that these theoretical rules must be modified by the distance the water has to flow before it arrives at the bridge. He stated that from the practice of the bridge builders in the valley of the Seine, the proportions of the water way to the area of the feeding ground of the streams, might be reckoned as follows; but evidently the conditions of the rainfall of the particular district under examination must affect the whole of this question, and the results indicated by M. de Belgrand must only be considered to show the relative proportions prevailing in the bridges of some parts of central Europe.

Very steeply inclined liasic deposits require a water way, per mile square of feeding ground equal to about $1\frac{1}{2}$ yard deep.

Granitic rocks	$1\frac{1}{3}$ yard deep.
Oxford clay	1·1 „
Common clays	·72 „
Chalk, or Oolites, only . . .	·03 „

These dimensions are not quite in accordance with those usually adopted in either very flat, or very mountainous districts; for in Holland, it is the custom to make the water way of bridges in the proportion of about 0·15 yard superficial for every square mile of back country; and in many granitic districts the water way is not made greater than in the proportion of 0·45 yard superficial per square mile. M. de Belgrand's observations are, however, the first which have been made in any philosophical or consecutive spirit; and they may be the more safely adopted, because they would rather lead to an error in favour of the stability of the work than otherwise.

But in addition to the consideration of the area of water way to be provided, in order to allow the free discharge of storm or flood waters, it is necessary to provide against the possibility of the bed of the river being affected by the increase in the velocity of the stream produced by the contraction of its lateral dimensions. Whatever changes therefore may be introduced in the shape of the water way of a river, in order to admit of the construction of a bridge, it is absolutely necessary to limit the mean velocity of the stream, at the periods even of its greatest flow, within the following limits, according to the nature of the strata it may flow over (Neville's 'Hydraulic formulæ'):—

25	feet	per minute	in soft alluvial deposits.
40	„	„	clayey beds.
60	„	„	sandy and silty beds.
120	„	„	gravelly.
180	„	„	strong gravelly.
240	„	„	shingly.
300	„	„	shingly and rocky.
400	„	„	and upwards in rocky formations.

It is essential also to the stability of a bridge that, even in flood times, the water should not rise to the underside of the keystone; and in settling the dimensions of the water way attention must be paid to the contraction of the fluid vein, produced by the various points of support. The interference those points of support produce upon the onward flow of the river gives rise to a species of heaping up of the water, as it were, on the upside of the bridge, and a consequent increase of velocity on the lower side: both of these phenomena, which depend upon local conditions, require to be taken into serious consideration in every case under observation. It follows, however, from their existence that the fewer the points of support of a bridge are, the less interference it will produce with the hydraulic conditions of the stream; and that unless very cogent reasons of economy should exist to induce a preference for small arches, large ones should be adopted. In countries exposed to severe frosts and sudden thaws, it is moreover necessary to guard against any danger from an accumulation of floating ice on the upper side of the bridge; and it is desirable that as far as possible the springings of the arches should be kept above the flood line. This precaution is more necessary when the shape of the arch is segmental, or semicircular, than when it is elliptical; but whatever form be adopted, the danger from floating ice must always be guarded against.

The forms to be given to the piers and to the arches of a bridge will depend upon several practical considerations. With respect to the former, it may be stated that they will depend principally upon the opening of the arches, and the description of resistance they themselves (the piers) are required to offer to the stream, or to the dynamical action of the arches. Upon the up-side of the stream in non-tidal

rivers, and on both sides in rivers susceptible of tidal action, the piers must be terminated by what are technically called *cut-waters*, rising to the extreme height of ordinary floods; and from direct experiments it would appear that the most advisable horizontal section to be given to such cut-waters is that of an equilateral spherical triangle, whose apex is presented to the stream. In so much as the piers alone are affected by the openings, their dimensions and form must depend upon their being made equivalent at least to the vertical effort they must support; and it is only in extraordinary cases that they are made of sufficient dimension to resist the lateral thrust of the arches. In fact, there are few important bridges in existence, erected over large rivers especially, in which the piers would remain upright, if the thrust of the respective arches were not carried over, as it were, through the whole series to the abutments; and if one arch in such bridges were withdrawn, all the others would most probably follow. As to the shape of the arches, that may often depend upon mere economical considerations. Semicircular or segmental arches are executed with the least expense, because, if stone be employed, all the voussoirs can be worked from the same mould, or if brick be employed, the labour of laying can be performed by even the commonest description of workmen. But, on the other hand, arches of either of these descriptions require, as we have seen, that the whole structure of the bridge should be kept at a considerable elevation; and in the case of segmental arches the lateral thrust upon the abutments is greater than in any other form. Æsthetically, a semi-ellipse, or a segment subtending an angle of 60°, are unquestionably the most elegant forms; and in large semi-elliptical arches it is desirable that the outline should be struck from a sufficient number of centres to ensure the flowing regularity of the curve. The arches of the bridge of Neuilly were struck from eleven centres.

The most important considerations to be borne in mind in designing a bridge are, that the foundations of the piers and abutments should be sufficiently strong to resist the weight brought upon them, and any accidental effort to which they may be exposed from floods or other extraneous causes. As the functions of the piers and abutments are merely to support the vertical pressures of the arches, and to resist any tendency towards a movement of rotation on their own edges, arising from the lateral thrust of the arches, it follows that the lighter they are, and the greater the area over which they distribute the effort, the less will they load the foundations, and the more satisfactorily will they perform the duty required of them. The positive effort to which they may be exposed is ascertained first by calculating the extreme passing load; then that of the structure above the arch; that of the arch itself; and finally, the dynamical efforts of these various loads. As to the passing load, it is customary to calculate upon 240 lbs. per foot superficial of the whole area in ordinary bridges; and in railway bridges, exposed to the action of rolling loads travelling at great velocities, it will be safer to quadruple this calculation. As to the weight of the superstructure, that is of course ascertained from its mere density and cubical contents; and it may be assumed, practically, to be distributed equally over the arch. The weight of the arch will of course also depend upon its density and its cubical contents; and these may practically be ascertained by making the depth of the crown or keystone equal to from $\frac{1}{30}$ to $\frac{1}{35}$ of the clear span, and tracing the extrados of the arch upon the principle that the vertical depth over any particular point of the intrados shall be equal to the depth of the keystone, multiplied by the cube of the radius, and divided by the cube of the height of the point considered above the chord line. The sum of the above partial weights will act upon the resisting points of a bridge with an effort equal to its total weight multiplied by the leverage; and, consequently, the moment of resistance of those points must be sufficiently in excess of the destructive effort exercised by the load to support its continuous action. In order to secure this condition, the resultant of the ultimate thrust should fall within the vertical line drawn from the foundations of the abutments through their centres of gravity; and the moment of resistance of the abutments, from its gravity alone, should be at least equal to three times the maximum effort to which it may be exposed. Of course, in such cases, the resistance to lateral displacement will be increased by the friction of the materials of the abutments upon their beds; and the tendency of the piers to turn over upon their inner edges will be also resisted by the adhesion of the cement, or mortar, employed. It is essential to observe that the above reasoning pre-supposes that the foundations themselves are able to sustain the whole of the weight thrown upon them; but as the importance of this detail of bridge-building is so very great, it will be essential to dwell hereafter somewhat at length on this part of the art.

The above remarks are made upon the supposition that the arch is in itself an arch of equilibrium, and that it has been constructed with sufficient care and skill to allow of its retaining its form when the temporary support, or *centering*, upon which it was built, shall have been withdrawn. They would hold with equal correctness, however, if the materials of which the arch is composed were of such a nature as to render the assemblage equivalent to a solid beam; and this actually occurs when brick-work set in hydraulic mortar, or in cement, or any other analogous small materials, are used. In either case, the load ultimately thrown upon the arch must never attain such limits as to bring the line of pressure beyond the vault itself, either on the side

of the extrados or of the intrados; for if this should take place, the vault itself is liable to be overthrown, under one or other of the conditions indicated in the previous article, ARCH. It is tolerably well known at present that the theoretical and practical rules adopted by engineers for calculating the thickness of arches, and for settling the form of the extrados, give results which are in excess of those rigorously required; and M. Yvon de Villarceau has even taken the pains to indicate the precise degree of waste, to be discovered according to his theoretical rules, in the most celebrated bridges actually executed. In a memoir, 'Sur l'Établissement des Arches de Pont,' Paris, 4to, 1854, that eminent mathematician has treated the investigation of the forms and thicknesses to be given to the vault upon a different system to the one usually adopted; for he takes as the unknown quantities in his investigations precisely those quantities which are assumed in the ordinary theory, and he seeks to determine the forms of intrados and extrados which would secure the greatest stability of a vault intended to support a load whose weight and mode of distribution are previously fixed; as also he supposes that the span and the rise of the arch are fixed. The reasoning upon which he supports his opinions is of the most elaborate description, but it involves the discussion of problems of such extreme complication, that it would be impossible to condense them within the limits of this article. The reader is therefore referred to the original treatise; and for the present it may suffice to say, that M. de Villarceau has arrived at the conclusion that, theoretically, the rise of complete arches should be made to vary between $\frac{1}{3}$ and $\frac{1}{4}$ of the span, without attaining either of those limits; and that the rise should approach the proportion of $\frac{1}{3}$ in arches of small spans, and of $\frac{1}{4}$ in arches of larger spans. Semicircular arches, he considers, ought only to be adopted in cases when, as in tunnels, the load may be considered infinite. A series of tables are appended to the memoir, in which are stated the values of the quantities applicable to the elements of the calculations required in the cases of segmental arches, or in semi-elliptical ones; and a section of an arch of the latter form, of 200 feet span, and 53 ft. 3½ in. rise, with a thickness of the keystone not exceeding 6 ft. 2 in., is also given. Such an arch would indeed exceed in boldness anything hitherto attempted; but it is to be observed, that the whole of M. de Villarceau's theory depends upon the correctness with which the surfaces of the joints of the voussoirs are originally reduced to their element which meets the curve of the centres of gravity, and the contact is subsequently restored upon equal portions of the plane of the joint on either side of that primitive element, so that the pressure must finally be distributed over the whole of the new joint. These conditions are only attainable with extreme difficulty, for defects of execution, or in the quality of the materials, would materially affect them; and indeed the movements which take place after withdrawing the centres of a bridge, are often of so serious a nature as to render it inexpedient or unwise, to adhere to the results of even the most rigorous mathematical investigations.

In the execution of an arch it is desirable, and indeed almost necessary, that the voussoirs should be in uneven numbers, disposed symmetrically upon either side of the keystone; and if there should be simply a band of ashlar voussoirs upon the edge, filled in with smaller rubble, or brickwork, the joints of the latter must range with those of the bands. Of late years, some very large bridges, such as the Maidenhead bridge of the Great Western railway, or the Pont aux Doubles, at Paris, have been executed entirely of small materials, which, in fact, do not act in any way whatever as arches; for the adhesion of the cement employed converts the whole mass into a solid body, which retains its form through the inherent powers of resistance of the cementing materials themselves. But whether the arch be composed of voussoirs able to move upon their beds, or of what may be styled artificial monoliths, the construction of the *centres* upon which the arch is to be formed, must always command serious attention on the part of the engineer. The principles upon which these centres are constructed, are much modified by local circumstances; for according to the facilities these may present for establishing intermediate points of support, it may be necessary to adopt particular descriptions of framing. The essential conditions of a centre may, however, be very briefly stated; they being in fact simply, that they should not be susceptible of deformation under the influence of the partial loads they will have to support, and that they should rigorously conform to the projected outline of the intrados; they must also be susceptible of being removed, after the completion of the work, without disturbing the arch itself. The centres are usually composed of timber framing, or trusses; either bearing upon the extremities of the opening, or upon intermediate points of support. Until within a few years the frames were made to rest upon wedges, and when the vaults were completed, these wedges were loosened by being driven back with hammers; but in the construction of some of the modern railway bridges of France, a system of placing bags filled with dry sand under the points of support, has been introduced with success. This ingenious system obviates the danger of jarring the fresh masonry in driving back the wedges, and it has the advantage of enabling the workmen to stop the descent of the centres at any time they may think proper. A description of it will be found in 'Les Annales des Ponts et Chaussées,' for November, 1849.

Whatever be the form, or the mode of bearing adopted, in executing the centres of a large bridge, it is necessary that it should be cross

braced, so as to hinder anything like lateral displacement of the trusses. It is equally important that the frames should not be allowed to rise under the action of the partial load; and, therefore, the crown of the centre must be tied down to the springing, and the crown itself must be weighted whilst the vault is being brought up symmetrically on the sides. As all wood framing is liable to some description of compression under the action of great loads, and as the materials of which every arch is composed are susceptible also of some degree of compression, it is customary to give an additional height to the centre beyond that which would rigorously be required if its outline were made to correspond exactly with the curve intended to be given to the intrados. There does not appear to be any rule for settling the height to be thus allowed; and evidently it must depend mainly upon the skill and attention of the workmen; but from the following table of the settlements of some arches, recorded by Claudel ('Formules à l'usage des Ingénieurs,' Paris, 1854), it will at once be seen that there is an absolute necessity for observing the precaution in question :—

Name.	System.	Span.	Settlement.
Nemours . .	Segmental.	53 ft. 2 in.	8 inches.
Nogent . .	Elliptical.	95 ,, 10 ,,	1 ft. 6 in.
Neuilly . . .	,,	128 ,, 0 ,,	2 ,, 2 ,,
Mantes . .	,,	128 ,, 0 ,,	1 ,, 11 ,,
St. Sauveur . .	,,	76 ,, 4 ,,	0 ,, 10½ ,,
Jéna . . .	Segmental.	91 ,, 10 ,,	0 ,, 5 ,,

The principles which must be applied in the construction of centres have been ably discussed in Robison's 'Mechanical Philosophy' (vol. i. p. 661, ed. 1822), and it will be necessary to revert to the subject in the article on CARPENTRY. For the present, then, it will suffice to say that, in fact, the framing of a centre must be itself an arch able to support the weight of the vault; and that it is essential to convert all the strains upon the various parts of which it is composed, as far as possible into efforts of compression. Cross strains must be carefully avoided, and it is not even desirable to trust to the timber to any great extent, as furnishing ties to the rest of the framing.

Timber bridges have been used very frequently in countries wherein that particular material is abundant, and where neither the importance of the traffic nor the wealth of the country would justify the outlay required for the erection of a permanent structure of masonry. Thus in Switzerland, Germany, America, and in our own colonial possessions wooden bridges are commonly met with; but the very perishable nature of the material must always render its use objectionable in the great majority of cases. When, however, local considerations render it desirable to resort to the use of wood, the principles which should guide the engineer in designing the bridge must be substantially the same as he would adopt in designing any other piece of carpentry, but perhaps it is more essential that he should guard against the effects of atmospheric action upon the various parts of the framing he uses, than it would be necessary to do in ordinary cases. Thus it should be established as a rule that the piers and abutments of wooden bridges must be of masonry of impermeable materials; that no important part of the framing should be bedded in the masonry in such a manner as to prevent the free circulation of air around it; that no water should be allowed to lodge in the joints, or to remain in the bearings, of the framing; and that all the movements which naturally take place in the wood should be allowed to take place without interference from the mode of construction. The framing itself must be put together upon the ordinary mechanical principles adopted in carpentry; but it may be desirable here to state, that in the earlier bridges the timber was used simply as girders or straight horizontal beams; then Palladio and the Italian architects introduced a system of trussing with tie-beams; the German and Swiss engineers habitually resorted to trusses without tie-beams, and in which the thrust was carried down to the feet of masses of masonry by means of inclined strutts, a system which has been applied with infinite modifications by the engineers of other nations; and latterly, the American engineers have resorted to the use of what may be called built beams, applied, in fact, as girders.

Of course the use of timber baulks as girders, can only be admitted when the openings are small, and the loads to be carried are not very great. In such cases the girders must be considered to be beams resting at each end on fixed supports, and loaded with a weight dependent upon the purposes the bridge is intended to fulfil. The resistance of a beam under such circumstances is directly proportional to its breadth multiplied by the square of its depth, and inversely proportional to the distance between the points of support. In most books upon construction are to be found tables of the multipliers to be used for ascertaining the transverse strength of the different kinds of wood, and in practice these tables are applied upon the supposition that the safe load should not exceed from $\frac{1}{4}$ to $\frac{1}{6}$ of the breaking weight ascertained thus :—

$$\frac{\text{tab. No.} \times \text{breadth} \times \text{depth}^2}{\text{length.}} = x.$$

Timber.	Transverse Strength.	Crushing Force, per square inch in lbs.
Ash	2026	9023
Beech	1560	9048
Birch	1900	4567
Elm	1030	10331
Mahogany . . .	..	8198
English oak . . .	1800	..
African . . .	2000	..
Red Pine . . .	1340	5375
Teak	2460	12101

In calculating the strength of lateral trusses, reference must be had to the principle upon which they are designed, and the motives which may determine the choice of any particular system are so numerous that it would be dangerous here to lay down any abstract rules on the subject, further than to say that the simpler a truss is, and the fewer the number of its parts, the better will it be fitted for its work, both in so far as its resistance to the efforts it is intended to support, or its susceptibility of repair, are concerned. The object aimed at in designing a truss is to form artificially a rigid beam, through which the weight is ultimately resolved into a vertical pressure upon the points of support; and the parts of the truss must be so put together as to allow the various efforts of compression and tension to balance one another in a permanently safe manner. Some of the timber bridges upon the Utica and Syracuse railway afforded excellent illustrations of the mode of putting together trusses of this description, and the reader is referred to Weale's work on 'Bridges,' 8vo, London, 1843, for an account, and illustrations of them; but the lattice, or Thorn's bridges, and the Long's bridges, as they are called in America, are the boldest specimens of this mode of spanning large openings yet attempted. The formula adopted by the French engineers for calculating the resistance of the former bridges may here be quoted, as this mode of construction has found so little favour in the eyes of our own engineers that no work upon the subject can be referred to. It is to M. Garella (in 'les Annales des Ponts et Chaussées,' for 1842) that we are indebted for the formula in question, which is (in mètres)—

$$2\,P = \frac{Rc\,(b'^3 - b''^3)}{3\,b'a}$$

and in it 2P = the safety load; R = a co-efficient of the strength of timber; c = the united thicknesses of the whaling pieces; b' = the height of the truss; b'' = the distance, vertically, between the whales; and a = the half span. The formulæ for calculating the strength of ordinary trusses are reserved for the articles CARPENTRY and TRUSS.

Amongst the timber bridges in which the load is supported by a framing under the line of the roadway, by means of which framing the load is thrown upon the abutments without the intervention of any tie-beam, the most remarkable are perhaps the bent timber bridges erected upon the system first introduced into England by Messrs. Green, of Newcastle. In these bridges the principal portion of the weight is thrown upon an arched rib, formed of thin planks, bent flat, and fastened to one another with treenails, thus producing a beam of great strength and elasticity; but the very elasticity of the beams is an element of their destruction, for on every occasion of their changing their form, the various parts of which they are composed become more or less opened, and thus allow moisture to penetrate to their interior. It has thence happened that, in railway bridges especially, where the movements are unusually great, the arched ribs of thin planks, and also, it may be added, of square timber, rapidly decay. In a treatise by Colonel Emy, 'Sur la Charpenterie,' Paris, 1837; and in a brochure by Colonel Ardant, 'Sur les Charpentes à grand Portée,' Paris, 1840; the various conditions affecting arched timber beams are elaborately discussed; and in Krafft's work 'l'Art de la Charpente,' Paris, 1805, will be found a full description of the German and Swiss bridges, constructed upon the various systems hitherto adopted, when it has been impossible to introduce tie-beams.

Metallic bridges, which are not built upon the suspension principle, are either of cast or of wrought iron, or of a combination of iron and wood work. As cast iron is better adapted to resist efforts of compression than efforts of tension, it is preferable to use it only in positions where it is exposed to the former kind of action, and therefore it is that habitually cast-iron bridges are of the form of arcs of circles, and composed of a number of voussoirs. With spans inferior to 24 or 30 feet, however, straight cast-iron girders are often used to carry the roadway of bridges; their dimensions of course being ascertained by the rules commonly adopted in calculating those for ordinary cast-iron beams. Mr. Eaton Hodgkinson has given some empirical rules upon this subject, which may be briefly stated to be, that the area of the bottom flange should be as nearly as possible six times that of the top one; and that the breaking weight in the centre (of a girder uniformly loaded and supported at both ends) may be ascertained as follows: Calling the sum of the area of the bottom flange multiplied by the depth of the beam a; the length of the bearing between the

points of support, b; both of which are expressed in inches; then $x = \frac{a\,b}{1028}$; the safe load for a railway bridge, however, is only $\frac{1}{6}$th of the breaking weight thus ascertained. Mr. Beardmore states that the above formula may be applied to ordinary wrought-iron beams by making the co-efficient 1500 instead of 1028.

When the opening of a bridge exceeds the dimension above quoted, it is necessary to resort to a cast-iron arched beam; or to one or other of the descriptions of wrought-iron girders lately introduced upon the lines of railway, which have modified the arts of construction in this country, perhaps quite as much as they have altered the relations of society. Wherever there is a sufficient clear space under the bridge to allow the traffic to be carried on uninterruptedly, it is preferable, within certain very wide limits of span, to use cast-iron arches; and the very remarkable bridges of Southwark, Newcastle High Level, Laira, Nevers, Tarrascon, &c., may be referred to as illustrating the principles and the practical details of such works. In these cases, all the action upon the cast-iron arches resolves itself into one of compression, which is precisely the most favourable condition for the use of this metal; but as it is essential in a cast-iron bridge to keep the springing of the arch above the water-line, it very frequently happens that it is impossible to keep the whole of it below the line of roadway, or the line of the application of the live weight. In such cases it is necessary either to suspend the roadway from a cast-iron arch rising above the roadway itself, which will render inevitable the introduction of a horizontal tie; or to resort to the use of framed beams, lattice, or tubular girders. The bridge over the Regent's Canal of the North-Western Railway is a good illustration of the former system; the Newark Dyke, the Boyne and the Britannia bridges, are respectively illustrations of the three systems of wrought-iron bridges above-mentioned. It would be preferable to describe the principles which are considered to apply to these various systems under the head of girders *triangular*, *lattice*, and *box*; or the reader may refer for an investigation of their conditions, to the works of Messrs. Edwin Clarke, Fairbairn, Hodgkinson, Tate, Latham, Humber, Moseley, &c., wherein their respective merits are fully and elaborately examined. And it may suffice here to say that, up to an opening of 150 feet, any of those three systems may be adopted in bridges having the supporting beams above the roadway, according to local considerations of economy; above 150 and under 300 feet span, the choice is limited to the lattice and plate-iron tubular bridges; whilst above 300 feet span the tubular bridges only are admissible. When the latter extraordinary dimensions are attained, the stability of the structure can only be ensured by the use of deep tubes, consisting of an upper and a lower boom, calculated to resist the respective efforts of extension and of compression to which all girders are exposed; and either of close-plated sides, as in the Britannia, or of open framework, as in the Saltash bridge. In the former of these colossal structures, both the upper and the lower booms were composed of a series of rectangular cells; whereas in the Saltash Bridge the upper boom was composed of a large elliptical tube connected with the tie girders by means of a series of suspension rods. It is asserted that by this arrangement a considerable economy is produced in the iron-work of the bridge.

A very efficient system of trussing, known under the name of the Bowstring girder, has been applied in some of the modern railway bridges which do not exceed 120 feet span. The principle upon which it is based consists, as its name implies, in a curved boom, with a tension-chain at the feet, solidly attached to the boom by a lateral framing; the roadway is carried in these bridges directly upon the tie-chains, so that the other parts of the framing act as parapets. A very good example of this description of bridge is to be seen upon the Bow branch of the Blackwall Railway. The advantage of this system consists in its admitting of the nearest practical approach, in the outline of the girder, to the form of a solid of the greatest resistance with the least amount of material, and in thus diminishing the permanent load of the whole structure.

Until the recent introduction of the plate-iron girders, the only mode by which a roadway could have been carried across a very wide span, when it was impossible to construct a cast-iron arch beneath, either on account of the deficient headway, or on account of the difficulties in the way of fixing centres, was by the application of the system of chain or suspension bridges, first applied on a large scale by Telford upon the Holyhead road, the scene of the greatest achievements of modern engineering. In suspension-bridges, the roadway is suspended by vertical rods to chains of flat iron links, or to iron-wire ropes, which hang from cradles or saddles carried by masonry or iron piers, and are continued on the opposite side to what are called the anchoring-wells. The chains in such cases have permanently to support an effort compounded of, 1, their own weight; 2, of the weight of the suspension-rods, which varies with the lengths of the latter; and 3, of the weight of the roadway, which may be considered to be uniform in the length of the span. But in addition to this permanent effort, it is necessary to take into account the rolling load, the action of wind upon the whole structure, and, as in the case of all iron bridges, by the way, the effect of variations in the temperature upon the various parts of the work. Local circumstances, also, may render it necessary to modify the general system of suspension-bridges; for at times it may be desirable to dispense with the piers and back chains, whilst in others

it may be necessary to introduce a series of spans. In the latter cases, the chains may either be attached to the respective piers, or they may be carried over a series of saddles; and, in fact, there are so many reasons for modifying the details of these bridges, that they can only with difficulty be brought under any general rules.

According to Navier (whose work, 'Mémoire sur les Ponts Suspendus,' Paris, 1830, is still the text-book upon this subject), the formulæ which may be considered to represent the maximum tension in the direction of the arcs, and the horizontal tension at the top of the piers are $T = \frac{P}{4}\sqrt{\frac{d^2}{4f^2}+1}$; and $Q = \frac{Pd}{8f}$; in which P is the total maximum load upon the arc; d, the span; and f, the versed sine. From these formulæ it appears, that the greater the versed sine the less strain is there upon the piers, or upon the chains themselves; but, at the same time, the length of the chain is necessarily increased, and the horizontal vibrations of the whole system are also rendered more dangerous, whilst the transverse vibrations are likewise increased. For these reasons, the ratio of the versed sine to the span of suspension-bridges is usually made to vary between the maximum of 1·7, to the minimum of 1·25; and in the Fribourg Bridge, the largest span hitherto attempted, the ratio is 1·14. The latter ratio is the one most commonly adopted. In all cases, and whatever be the material of the chains, the suspension-rods are placed at equal distances horizontally.

There is a remarkable difference in the theory and practice of English and of Continental engineers, with respect to the manner of resisting the vibrations to which the floors of suspension-bridges are exposed. English engineers, indeed, consider that the weight and rigidity of the whole structure are desirable conditions; whereas foreign engineers make the several parts as light and as elastic as possible. So many accidents have happened to suspension-bridges constructed on either of these principles, that it would be impossible to say which of them is the more correct; but it certainly would appear that when drawn iron suspension-rods are used instead of wire ones, it is very desirable to keep the roadway as stiff as it can be made, for if any undulations of great amplitude, such as have been described by Mr. Provis in his account of the Menai Bridge, should occur, the rods are very likely to break. Great stiffness may be given by trussing the hand-rail; by carrying the platform through the piers; and by introducing a system of cross-bracing under the roadways. These precautions, however, may be adopted upon either the English or the foreign systems above mentioned.

One of the most important parts of a suspension-bridge is the anchoring of the end of the chain, so as to interfere as little as possible with the contraction and expansion of its metal, and yet to resist the tension. Great precautions require to be taken, especially in the tying-down wells, to protect the chains from oxidation; and it may be interesting to add, that some of the worst accidents to suspension-bridges have arisen from the destruction of the sunk part of the back chains, precisely from this cause. This was the case with the bridge at Angers, which fell in consequence of the rusting of the wire-ropes in the wells; and so much are the said wire-ropes exposed to this particular danger, that it would appear to be desirable to exclude them entirely from that part of the work. In the open air, or in positions where they can be easily examined, however, iron-wire ropes present many advantages over the solid bar-iron chains or suspension-rods.

The wire-ropes used on the Continent consist, in fact, simply of annealed wires in close juxtaposition, bound round at intervals so as to prevent any longitudinal or lateral motion. They were originally introduced by M. Seguin, and described by him in a 'Mémoire sur les Ponts en Fil de Fer,' Paris, 1826; and have been successfully applied in an infinite number of cases, amongst others, in the Fribourg and the Niagara bridges: the latter is even used to carry a railway. A description of the Fribourg Bridge will be found in the 'Annales des Ponts et Chaussées' for 1835; a description of the great bridge, since fallen, of La Roche Bernard was published by M. Leblanc in 1841; and a description of the Niagara Bridge is to be found in Weale's 'Papers and Practical Illustrations of Public Works, 1856,' to which the reader is referred for details of the mode of forming the ropes, and of calculating their resistance. In the 'Annales des Ponts et Chaussées' for 1842 there is also to be found a description of an ingenious system of forming the cables and suspension-rods of hoop-iron instead of wire, which had been shortly before applied by Messrs. Flachat and Petiet in the construction of a bridge at Suresnes, near Paris; and there are to be found in the same valuable publication, especially of the period between 1832 and 1849, a series of interesting notices upon the various descriptions of suspension-bridges, and the accidents to which they are exposed. The latter have, unfortunately been very numerous of late years; and there certainly is at present, in consequence of these accidents, a tendency in the public estimation to undervalue this very useful and economical method of bridge-building. Even chain suspension-bridges have shared the disfavour of the iron-wire ones; and, in Paris especially, they have been pulled down with a most imperial disregard for expense; but certainly, if due precautions be observed, there can be no reason for the sudden revulsion in public opinion which has taken place with respect to suspension-bridges of all kinds; and the use of the woven-wire ropes especially would seem to obviate many of the objections which practically apply to the ordinary parallel stranded ropes used by the French engineers.

The "Dredge's Suspension-bridges," which were very favourably received in England a few years since, have been even more unfortunate than the other modifications of this style of bridge. They were principally remarkable for the attempted application in them of the theoretical principle that the strength, and consequently the weight, of the chain in any part of its length should diminish in proportion to the strain likely to be thrown upon it, and also for the peculiar inclined position of the suspension-rods. Such a system, however, is deficient in its powers of resistance to either horizontal or transverse waves, precisely at the point where their action is the greatest; and the consequence has been that, in the small bridges of the Regent's Park for instance, the platforms have been obliged in many cases to be supported by an intermediate framing.

It must be observed that, whatever be the description of chain employed in a suspension-bridge, the greatest danger to which that class of structures is exposed arises from regular impulses repeated at isochronous intervals. Occasionally the gusts of wind in storms occur thus; and the regular cadence of a body of troops passing over a suspension-bridge will also excite a vibration of a very dangerous character. In the case of the Pesth Bridge, however, the dimensions given to the various parts of the work have been sufficient to enable that structure to resist even the passage of troops in large bodies, in the hurry of a fierce fight.

The French government do not allow greater permanent weights than those quoted below to be applied to the respective materials named in the table; and they require that the dimensions of the various parts of the works should be calculated so as to present the sectional areas corresponding with the safety loads thus indicated.

Chain cables, safe load, per inch superficial . . .	17,073 lbs.
Iron wire cables, safe load, per inch superficial . .	25,610 ,,
Vat hoop iron cables, safe load, per inch superficial .	19,913 ,,

Rope bridges are so seldom used that it may suffice to refer to Sir Howard Douglas's work on Military Bridges for the details connected with them. Skew bridges, being only practical varieties of ordinary bridges, will be noticed under that head. [Skew Bridge.]

Hitherto nothing has been said in this article about the mode of executing the foundations of bridges, for the reason that the same principles applying to those portions of all such buildings, it was considered desirable to notice first the modes of forming the superstructures, because they, in some cases, affected the details of the foundations intended to carry them. Now, the foundations of a bridge are required to resist two kinds of effort; namely, the vertical pressure of the load ultimately brought upon them, and the lateral thrust of the arches. Moreover, they must be executed in such a manner as to be able to resist any tendency on the part of external agencies to undermine the natural surfaces upon which they rest: this latter consideration applies with particular force to the foundations of bridges when erected in running water.

The powers of a foundation to resist the lateral displacement of the superstructure, depend, it may here be observed, upon the dead weight of that superstructure and the resistance of the bearing surface to motion, either through the adhesion of the material, or through the friction it may produce. This part of the investigation would be better treated under the head of Friction, and therefore the subsequent remarks refer only to the resistance of foundations to vertical loads.

The vertical pressure must of course be resisted by distributing the weight it represents over a base of practically incompressible materials. Of the natural soils there may be considered to be three great divisions, so far as regards their powers of resistance to efforts of compression; and they respectively require to be treated according to their powers of resistance. The first of these divisions is composed of the hard rocks, which can only be worked by the pick or by the use of gunpowder. The second is composed of sands, gravels, loams, clays, and other such easily worked materials, but which are practically incompressible when prevented from spreading laterally. The third is composed of the light earthy soils, of peat, mud, or other substances which are almost of a semi-fluid nature; and it is precisely with the latter that the greatest difficulties are encountered, at the same time that they are the most frequently to be met with in the beds and banks of rivers. As the differences between the various classes of foundations are so distinctly marked, and are so important in their practical bearings, the greatest care must be exercised in ascertaining the conditions actually prevailing in any case under investigation; and as it may at times happen that the top or upper bed of any particular situation may rest upon a softer and highly compressible substratum, it is essential that the observations upon the foundations of an intended bridge should be carried down to a very considerable depth, by means of shafts, wells, or borings. It may also happen that the natural stratum of any particular place may be able to resist the decomposing action of the air so long as the stratum itself is undisturbed; but that directly the outer surfaces are removed, as will often be the case when excavations are made for the purpose of receiving new foundations, the inner portions of the stratum will begin to decay. In fact, very careful examinations must be made of the geological nature and the mechanical structure of the materials about to be built upon, and the load brought upon them must be proportioned to their least powers of resistance. The boring tools must in such cases be skilfully and liberally applied, in order to

ascertain the real character of the formations upon which any great structure is about to be erected; for the indications obtained by means of trial piles are very likely to prove deceptive, because the resistance to their descent may frequently be so great in an upper stratum lying upon a soft under stratum, as to lead to very false conclusions on the subject of the ultimate resistance to a vertical load.

If the natural foundations should however have been studied carefully, in the manner above recommended, they must be treated according to their peculiar characters, as follows: The rocks and other resisting strata must be carefully levelled, without destroying the asperities on their surfaces which might be likely to increase the friction upon the bed. Any great inequalities of surface may be overcome by the application of a bed of concrete; but whenever this material is used, it must be composed of the best description of hydraulic lime or cement, and prepared with great care, so as to avoid anything like unequal settlements. When the natural foundations are composed of the sands, loams, and such heterogeneous materials, it becomes necessary to adopt precautions for the purpose of preventing any tendency to undermining; and with this intention, the position about to be covered must be surrounded with an inclosure of wood or iron piling; and, in rapid rivers especially, the level of the new foundations must be carried down so far as to obviate any danger of their being laid bare, by the removal of the subsoil, by the waters likely to find their way under them. The load must be distributed evenly over surfaces of this description, either by means of a timber platform, a coating of concrete, or a bed of large stones.

When the natural foundations consist of compressible strata, such as peat, soft mud, or other analogous alluvial deposits, of a considerable thickness, it becomes necessary to resort to the use of piles of wood or of iron; and when, as in the majority of the river-beds of India, there is a great depth of running sand, it may become necessary even to sink wells, which are subsequently to be filled in with concrete. When wooden piles are used, care must be observed in the selection of the kind of wood employed; for beech, the material most usually adopted on the Continent, decays rapidly when exposed to alternations of wetness and dryness; elm resists more satisfactorily in situations so exposed; whilst oak and fir, especially if free from sap in the commencement, will last longer than either of the above woods. There is another danger to which wood piles are exposed,—namely, the attacks of the boring worm; and as it appears that the process of creosoting renders wood so distasteful to those creatures that they will not touch it when so prepared, it would seem to be essential to subject all piles to that process. It is said that the boring insects exercise their ravages more particularly upon piles driven into the strata able to furnish them with the carbonate of lime requisite for their growth; but, unfortunately, they are nearly as destructive to piles driven into silicious sands, and the only places which seem to enjoy immunity from their attacks are those situated near the outlets of sewers or drains containing much sulphuretted hydrogen.

Piles are called, according to the positions they occupy in a foundation,—1, *Gauge piles*, or those driven for the purpose of defining the limits of the ground, or of guiding the position of the rest of the work; 2, *Sheet* or *close piles*, which form a continuous inclosure, the term close piles being used when whole baulks are employed, and sheet piles when timber of smaller scantling is employed. These various descriptions of piles are united by *whales*, or horizontal ties, by cross braces, and occasionally by struts. Their entry into the ground is facilitated by cutting the ends into a pyramidal form, and by fastening either cast or wrought iron *shoes* upon the point; the heads of the piles are *hooped* with wrought iron, in order to prevent their being split in driving. Occasionally however piles are driven with a broad flat end, as in foundations upon a great thickness of compressible mud; and Peyronnet considered that this system was advantageous when the middle of the piles was situated at nearly the mean level of the water. It is important, when piles are thus driven with the small end downwards, to begin by the outer ones, and then proceed inwards.

The weight to be brought upon the top of a pile is usually calculated upon the supposition that it would derive no support from the ground into which it is driven; and Rondelet has given a series of tables in which he states the safe load to be placed on piles of certain heights and scantlings, calculated upon the principle of their being able to support those loads in the open air. It may briefly be stated that, provided the height of the pile should not exceed 16 times the scantling (or diameter), it may safely be loaded with from 430 to 500 lbs. per superficial inch of the sectional area.

When the piles are driven into soft ground of considerable depth, it is customary to leave off driving when a certain resistance to their progress is attained. This resistance is made proportionate to the weight of the ram, and to the height through which it falls; but it must be observed, that there is danger in the use of any description of machinery by which frequent heavy blows are struck upon the pile-heads; for in such cases, their heads may either be set on fire, or knocked up into a spongy mass, or the piles may be split. Moreover, as there is a tendency, when frequent heavy blows are struck upon the piles, to produce a state of vibration in the ground around them, which may seriously interfere with their descent, it would appear to be preferable to employ for pile-driving only such machinery as is capable of striking heavy blows at tolerably distant intervals. Of course, however, this rule must be considered to be exposed to many exceptions, and great judgment will be required in the choice of the mode of pile-driving to be employed in any particular case. The very valuable machinery introduced by Mr. Nasmyth has, for instance, failed as signally in some cases as it has succeeded in others.

Some very ingenious systems of sinking what may be termed hollow cylindrical piles of large diameter (which are subsequently filled in with concrete in the same manner as the brick wells before alluded to, as being used in India), have lately been introduced in England. The first serious attempt of this nature was made by Dr. Potts, who caused the cylinders to descend by pneumatic pressure, and upon this system founded very successfully some of the bridges on the Richmond, and the Chester and Holyhead lines of railway. Great improvements upon this system have been made by Mr. Hughes, who directed the works of the Rochester bridge, under Sir William Cubitt; and more recently still, the continental engineers have applied upon a great scale the method of sinking cylinders by the use of pneumatic machinery. A description of the methods respectively adopted may be found in a small brochure published by Mr. Hughes; and in vol. xvi. of the 'Annales des Travaux publics de la Belgiques,' for 1857-58.

The observations above made with respect to pile-driving were made upon the supposition that the piles were to be placed in such positions as to allow of their being driven in the open air; but if they should be entirely under the water-line of the river to be built in, it may be necessary to construct a coffer-dam, or a temporary enclosure, for the purpose of pumping out the water, and allowing the workmen to operate freely in the dry. The principles upon which coffer-dams are formed, are discussed under that head [COFFER-DAM]; but it is necessary here to remark, that their use is not now considered to be so indispensable as it was formerly. When the extreme limit of the scour to which a river's bed is exposed has been ascertained, and a solid substratum is known to exist below that limit, it is found to be sufficient, especially in the cases of bridges of large span, to surround the intended positions of the piers by an enclosure of close piling, and then to dredge out the alluvial matter, or silt, upon the top of the resisting substratum, and to fill in the space thus cleared with good hydraulic concrete, nearly up to the water-line. Nearly all the large bridges lately erected upon the continent have been founded in this manner; and though the majority of the older members of the engineering profession in England still adhere to the more expensive system of coffer-dam foundations, there appears to be no substantial reason for the non-adoption of the continental system in our own country. In fact, it has been applied by Messrs. Vignolles, Page, &c., hitherto with success. The important conditions to be aimed at in forming such foundations are, firstly, that they should be protected from any possible danger of undermining; and then, that the concrete filled in between the sheet piling should set rapidly, and permanently. So much indeed depends upon the composition of the concrete used in all descriptions of foundations, that it is advisable to devote a separate article to its consideration. [CONCRETE.]

In the old Westminster Bridge, Labeleye introduced a system of foundations, which perhaps may still be safely applied in some positions, but which has proved to be signally unfit for the beds of rivers exposed to great scouring actions. He used, in this, large caissons, or boxes, of the extreme size of the intended piers; and he caused them to be sunk upon a bed supposed to have been prepared by dredging, to receive them: the masonry of the piers was then continued upon the floor thus formed. Unfortunately the natural bed of the Thames at the place where Labeleye tried his experiment was of a very variable character, and the unequal resistances it has offered to the weights brought upon the caissons have allowed the piers and arches to move in so dangerous a manner that the bridge must be pulled down within about a century from its construction. De Cessart applied the same system to some of the bridges over the Loire; and Smeaton continued its use in our own country, in the foundations of Ramsgate pier, for instance; but at the present day, engineers have almost unanimously condemned a mode of construction known to be exposed to very serious and irreparable accidents.

Floating, turning, lifting, and pontoon bridges being merely local modifications of this class of constructions, are briefly noticed under their respective heads.

We add a table of the form, material, and size of the principal bridges, aqueducts, and viaducts, of which the construction and proportions have been obtained:—

The column marked 1, indicates the total length between abutments; 2, the No. of arches; 3, the form of arch; 4, the chord of principal span; and 5, the ver. sin. of principal span.

The capital letters in the first column indicate the material:—B. brick; I. iron; W.I. wrought iron; C.I. cast iron; M. marble; S. stone; T. timber.

NAME OF STRUCTURE.		1 Feet.	2	3	4 Ft.	4 In.	5 Ft.	5 In.
Agen	S.	252	3	Segment.	59	6	13	0
Alcantara	S.	612	6	Semicirc.	100	0	50	0
Alma	S.	452	3	Elliptical	141	0	28	0
Almaraz	S.	530	2	Semicirc. the prin.	137	0	68	6
Arcole	W.I.		1	Segment.	262	6	20	9
Arcueuil Aqueduct	S.	1279	9	Semicirc.	27	0	13	6

Name of Structure.	1 Feet.	2	3	4 Ft.	4 In.	5 Ft.	5 In.
Aricia Viaduct . . . S.	885	18	Semicirc.	30	0	15	0
Athlone . . . . W.I.	564	2 prin.	Truss	165	0		
Avon Viaduct . . . S.	725	11	Elliptical	50	0	16	0
Ballochmyle Viaduct . . S.	645	7	Semicirc.	180	0	90	0
Bamberg . . . . T.		1	Built ribs	205	8		
Barentin Viaduct . . . S.	1545	27	Semicirc.	50	0	25	0
Barnes . . . . C.I.	380	3	Segment.	120	0	12	0
Bassano . . . . T.	209	5	Truss	41	0		
Beaugency Viaduct . . S.	911	25	Semicirc.	27	6	13	9
Bellecour . . . . S.	417	5	Elliptical	68	3	23	0
Bergehette . . . . S.	280	4	Semicirc.	49	0	24	6
Berne . . . . . S.	405	3	Segment.	157	6	63	0
Bewdley . . . . . S.	187	3	Segment.	60	0	18	0
Bideford . . . . . S.	720	24	Ogival	27	0		
Bietigheim Viaduct . . S.	936	21	Semicirc.	37	6	18	9
Birkwood Burn . . . S.	98	3	Semicirc.	30	0	15	0
Biscari Aqueduct . . S.	1222	31	Ogival	95	0	81	0
Blackfriars . . . . . S.	995	9	Elliptical	100	0	40	0
Bourbon . . . . . W.I.	250	2	Suspen.	120	0		
Bow . . . . . S.		1	Elliptical	66	0	14	0
Boyne* . . . . . W.I.	1760	3 prin.		250	0		
Brighton Viaduct . . . B.	960	27	26 Semic.	30	0	15	0
			1 Ellipt.	50	0	15	0
Bristol . . . . . S.	135	2	Ogival	59	0	17	0
Britannia . . . . . W.I.	1488	4	Tubular	459	3		
Cabriel . . . . . S.	304	7	Semicirc.	54	0	27	0
Capo-Dorso . . . . S.		1	Semicirc.	96	0	48	0
Carlisle . . . . . S.	370	5	Elliptical	65	0	20	0
Carpentras Aqueduct . . S.	2558	?	Semicirc.	76	0	38	0
Cart . . . . . S.		1	Segment.	85	0	18	0
Cartland Craigs . . . S.	180	3	Semicirc.	52	0	26	0
Caserta Aqueduct . . S.	1687	33	Semicirc.	25	0	12	6
Ceret . . . . . S.		1	Semicirc.	147	6	73	9
Cesse . . . . . S.	188	3	Elliptical	62	6	21	0
Chalons . . . . . S.	328	5	Semicirc.	64	0	32	0
Chaumont Viaduct . .	1968	50	Semicirc.	33	0	16	6
Chavanes . . . . . S.	420	7	Elliptical	42	8	16	0
Chelsea	700	3	Suspen.	353	0	30	0
Chepstow . . C. and W.I.	628	4	Tubular	300	0		
Chepstow . . . . . C.I.	353	5	Segment.	112	0	14	0
Chester . . . . . S.	340	1	Segment.	200	0	42	0
Chirk Aqueduct . . . S.	710	10	Semicirc.	40	0	20	0
Civita Castellana Aq. (Roman) S.	820	?	Semicirc.	87	3	43	7½
Coldstream . . . . S.	355	5	Segment.	60	8	18	0
Commercial Road . . . W.I.		1	Fram.trus	130	0		
Congleton Viaduct . . S.	2870	41	Segment.	60	0	21	0
Conon . . . . . S.	295	5	Segment.	65	0	20	0
Cremera . . . . . S.	245	3	Semicirc.	74	6	37	3
Crumlin Viaduct . . . I.	1050	7	Truss gird.	135	0		
Darlaston . . . . S.		1	Segment.	87	0	14	0
De la Fure Viaduct . . S.	888	16	Semicirc.	46	0	23	0
Dean . . . . . S.	450	4	Segment.	90	0	30	0
Dee Viaduct . . . . S.	1388	19	Semicirc.	60	0	30	0
Della Trinita . . . . S.	350	3	Elliptical	95	9	15	2
Dinan Viaduct . . . S.	635	10	Semicirc.	52	0	26	0
Dinting Vale Viaduct . T.	1452	5 prin.	Segment.	125	0	24	0
Dolhain Viaduct . . . S.	786	20	Semicirc.	32	6	16	3
Dora Riparia . . . . S.		1	Segment.	147	8	18	0
Drôme . . . . . S.	296	3	Elliptical	95	9	33	0
Dumballoch . . . . S.	216	3	Segment.	64	0	18	0
Dunkeld . . . . . S.	470	5	Segment.	90	0	30	0
Earn . . . . . S.	247	3	Elliptical	75	0	19	0
Eauplet . . . . . T.	1148	8	Seg. ribs	131	0	20	0
Ellicot's Mills . . . T.	308	2	Fram.trus	150	0		
Elsterthal Viaduct . . S.	892	6	Elliptical	93	0	56	0
Emilius . . . . . S.	550	7	Semicirc.	77	9	38	10½
Fabricius . . . . . S.	202	2	Semicirc.	83	0	41	6
Florence . . . . . M.		1	Segment.	138	6	31	0
Florence (Covered) . . S.	344	3	Segment.	98	0	18	0
Fouchard . . . . . S.	295	3	Segment.	85	3	9	7
Franzdorf Viaduct . . S.	1916	25	Semicirc.	55	0	27	6
Fribourg			Suspen.	880	3	63	3
Gignac . . . . . S.	412	3	Elliptical	160	0	53	0
Glasgow . . . . . S.	455	7	Segment.	58	0	11	0
Glasgow . . . . . S.	406	5	Segment.	80	0	12	6
Gloucester . . . . S.	278	1	Elliptical	150	0	35	0
Godavery Irrigation Aqued. S.	2356	49	Segment.	40	0	7	0
Goeltzchthal Viaduct . . S.	1900	30	Elliptical	93	10	57	0
Grenoble . . . . . S.	286	3	Elliptical	88	6	23	0
Guetin (Canal Aqueduct) . S.	1476	18	Semicirc.	52	4	26	2
Haarlaem River Aqueduct . S.	1450	15	Semicirc.	80	0	40	6
Hexham . . . . . S.	524	9	Segment.	51	0	17	0
Hungerford	1350	3	Suspen.	676	6	50	0
Indre Viaduct . . . . S.	2463	59	Semicirc.	32	0	16	0
Invalides, 1	480	1	Suspen.	510	0	34	0
Invalides, 2	412	3	Suspen.	223	0	28	0
Invalides, 3 . . . S.	468	4	Segment.	105	0	14	0
Italian Irrigation Aquedcts. S.	385	5	Segment.	87	6	30	0
S.	500	3	Segment.	100	0	35	0
Izbol (Spanish) . . . S.		1	Semicirc.	55	0	27	6
Janiculum . . . . S.	310	3	Semicirc.	83	4	41	8
Jena . . . . . S.	546	5	Segment.	91	10	10	9
Kandel . . . . . T.		1	Fram.trus	166	3		

* Wrought-iron lattice for three principal arches.

Name of Structure.	1 Feet.	2	3	4 Ft.	4 In.	5 Ft.	5 In.
Kelso . . . . . S.	410	5	Elliptical	72	0	21	0
Kieff	2562	4	Suspen.	416	0	30	0
Kincardine . . . . S.	273	6	Segment.	60	0	20	0
La Roche Bernard . .		1	Suspen.	650	4	50	0
Landore Viaduct . . . T.	1760		Truss	110	0		
Langon . . . . . W.I.	678	3	Girder	243	6		
Larbert . . . . . S.	432	14	Segment.	40	0	12	0
Lary . . . . . C.I.	512	5	Segment.	100	0	15	0
Lea Cut . . . . . S.		1	Segment.	87	0	16	0
Libourne . . . . . S.	690	9	Elliptical	66	0	22	0
Limerick . . . . . S.	412	5	Elliptical	70	0	17	6
Lisbon Aqueduct . . S.	3805	25	Ogival				
Lockwood Viaduct . . S.	1428	36	Semicirc.	30	0	15	0
Loebau Viaduct . . S.	624	9	Semicirc.	55	9	27	10½
London . . . . . S.	784	5	Elliptical	152	0	37	0
Lough Atalia . . . . W.I.	226	4	Girder	60	0		
Louret . . . . . T.		1	Fram.trus	78	0		
Lumes (Meuse) . . . . C.I.	240	3	Segment.	73	9	7	4
Lune Aqueduct . . . S.	420	5	Semicirc.	70	0	35	0
Maidenhead . . . . B.	286	2	Elliptical	128	0	22	0
Maintenon Aqueduct . . S.	16367	?	Semicirc.	43	6	21	9
Malaunay Viaduct . . S.	500	8	Semicirc.	50	0	25	0
Mammæa . . . . . S.	195	3	Semicirc.	64	0	32	0
Mans . . . . . S.	188	3	Elliptical	55	6	22	6
Mehaga . . . . . T.		1	Built ribs	147	0		
Menai			Suspen.	570	0	43	0
Merida Aqueduct . . . S.	?	?	Semicirc.	18	0	9	0
Mersey . . . . . S.	447	12	Segment. & Semic.	75	0	14	0
Metz (Roman Aqueduct) . S.	?	?	Semicirc.	18	0	9	0
Millingen . . . . . T.		1	Fram.trus	157	6		
Mont Louis . . . . . S.	1257	12	Elliptical	81	0	24	0
Montford . . . . . S.	180	3	Elliptical	58	0	24	0
Montpellier Aqueduct . . S.	3214	?	Semicirc.	28	0	14	0
Mühldorf . . . . T.	370	3	Truss	119	0		
Musselburgh . . . S.	231	5	Segment.	45	0	6	0
Nabresina . . . . S.	2115	42	Semicirc.	65	0	32	6
Namur . . . . . S.	450	5	Segment.	82	0	11	0
Navilly . . . . . S.	466	5	Elliptical	76	9	26	0
Nemours . . . . . S.	180	3	Segment.	53	3	5	0
Neuilly . . . . . S.	865	5	Elliptical	128	0	32	0
Nevers . . . . . C.I.	1066	7	Segment.	137	9	15	0
New Westminster C. and W.I.	900	7	Elliptical	120	0	22	0
Newark Dyke . . . . I.		1	Truss grd.	240	6		
Newcastle High Level . C.I.	820	6		124	10		
Newtown Stewart . . . S.	252	5	Segment.	50	0	7	0
Niagara		1	Suspen.	816	0	56	0
Nogent sur Marne Viaduct . S.	2722	34	Semicirc.	101	6	50	9
Old London . . . . S.	926	19	Segment.	65	0	22	0
Orb Canal Aqueduct . . S.	648	7	Elliptical	56	0	22	0
Orense . . . . . S.	1209	6	Ogival	144	0	90	0
Orleans . . . . . S.	1110	9	Elliptical	106	6	32	0
Orviel . . . . . S.	126	3	Elliptical	38	6	9	0
Ouse Burn Dean Viaduct . T.	630	5	Segment.	116	0	32	0
Ouse Valley Viaduct . . B.	1290	37	Semicirc.	30	0	15	0
Pavia . . . . . S.	620	7	Ogival	70	0	60	0
Peacock . . . . . T.	660	5	Lattice	136	6		
Perth . . . . . S.	606	7	Segment.	75	0	28	0
Pesth		3	Suspen.	643	0	50	0
Philadelphia . . . . T.		1	Seg. ribs	340	0		
Pont de la Concorde . . S.	490	5	Segment.	93	9	10	0
Pont du Gard Aqueduct . S.	879	11	Semicirc.	77	0	38	6
Pont y Cyssylte Aqueduct . C.I.	1007	19	Segment.	45	0	7	0
Ponte dell' Arcate Aqueduct S.	660	14	Semicirc.	36	0	18	0
Port de Pile . . . . S.	340	3	Elliptical	103	0	36	0
Portage Viaduct . . . T.	876						
Potarch . . . . . S.	218	3	Segment.	70	0	23	0
Ponte Corvo . . . . S.	640	7	Semicirc.	93	6	46	9
Pyrgos Aqueduct . . . S.	723	21	Semicirc.	16	0	8	0
Rattisbonne . . . . S.	994	15	Semicirc.	52	6	26	3
Roanne . . . . . S.	622	7	Elliptical	76	6	27	0
Rochester, New . . . . C.I.	498	3	Segment.	170	0	17	0
Rochester, Old . . . S.	560	10	Segment.	80	0	21	0
Royal Border Bridge, Berwick S.	2160	28	Semicirc.	61	6	30	9
Rialto . . . . . S.		1	Segment.	94	6	21	0
Ribble . . . . . S.	675	5	Elliptical	120	0	30	0
Rimini . . . . . S.	150	5	Semicirc.	28	6	14	3
Roman Aqued., near Lyon . S.	765	26	Semicirc.	20	0	10	0
Roquefavour Aqueduct . . S.	1279	16	Semicirc.	50	0	25	0
Salaro . . . . . S.	310	5	Semicirc.	68	9	34	4½
			the 3 prin.				
Saltash . . . . . W.I.	2195	19	Girder	433	6		
Sarstedt . . . . . W.I.	256	3	Plate gird.	93	3		
Saumur . . . . . S.	920	12	Elliptical	64	0	23	0
Schaffhausen . . . T.	376	2	Fram.trus	192	10		
Schildesche Viaduct . . S.	1230	28	Semicirc.	33	9	16	10½
Schuylkill . . . . T.	1000	7	Fram.trus	136	0		
Sharding . . . . . T.		1	Fram.trus	191	4		
Sitterbrucke . . . . I.	385	3	Lattice	127	0		
Solani Aqueduct . . S.	1050	15	Segment.	50	0	10	0
Southwark . . . . C.I.	710	3	Segment.	240	0	24	0
Spoletto . . . . . S.	876	9	Ogival	70	4?		
St. Angelo . . . . S.	520	7	Semicirc.	64	0	32	0
St. Anne's . . . . W.I.	1350	16	Tubular	200	0		
St. Esprit . . . . S.	2690	19	Segment.	102	4	30	

Name of Structure.		1	2	3	4 Ft.	4 In.	5 Ft.	5 In.
St. Germain Viaduct	S.	820	20	Semicirc.	33	0	16	6
St. Maxence	S.	268	3	Segment.	77	9	6	4
St. Petersburgh	C.I.	1090	8	Segment.	150	0	13	0
Staines	S.	410	5	Segment.	74	0	9	3
Stanley Ferry Aqueduct	C.I.	216	1	Suspen.	155	0		
Stockport	S.	1792	22	Semicirc.	63	0	31	6
Stoneleigh	S.		1	Segment.	92	0	14	0
Stourport	T.		1	Trussd. rib	115	0	30	0
Sublicius	T.	?	?	Girder				
Tablete (Spanish)	S.		1	Semicirc.	55	0	27	6
Taff			1	Segment.	134	6	34	0
Tarascon	C.I.	1575	7	Segment.	204	4	16	6
Tarragona (Roman Aqued.)	S.	895	25	Semicirc.	25	0	12	6
Tewkesbury	C.I.		6	Segment.	170	10	17	0
Tongueland	S.		1	Segment.	112	0	35	0
Toulouse	S.	735	7	Elliptical	112	10	46	0
Tours	S.	1422	15	Elliptical	80	0	29	0
Trenton (Delaware)	T.	960	5	Fram.trus	200	0		
Trent	C.I.	330	3	Segment.	100	0	10	0
Tresso	S.		1	Segment.	251	0	88	0
Tyne Viaduct	S.	902	4	Semicirc.	160	0	80	0
Union (Tweed) Viaduct		385	1	Suspen.	449	0	30	0
Val Benoit	S.	366	5	Segment.	65	6	9	0
Val Fleury Viaduct	S.	468	7	Semicirc.	35	0	17	6
Vale Royal Viaduct	S.	330		Segment.	60	0	15	0
Vauxhall	C.I.	798	9	Segment.	78	0	11	0
Verona	S.	305	3	Elliptical the prin.	159	9	53	3
Verona (Coccaglio)	S.	1328	17	Ogival	57	6	52	0
Vicenza	S.		1	Segment.	111	6	35	0
Vicenza	S.	107	3	Segment.	34	2	12	0
Victoria (St. Lawrence)	W.I.	9437		Tubular	330	0		
Waltenhoffen	T.		1	Truss	172	0		
Walton	T.	229	3	Fram.trus	130	0		
Waterloo	S.	1380	9	Elliptical	120	0	35	0
Weise (Baden)	W.I.		1	Lattice gir.	142	0		
Wittenberg	T.	?	?	Lattice	176	0		

BRIDGE HEAD, or *Tête de Pont*, is a fortification covering that extremity of a bridge which is nearest to the position occupied by the enemy, in order, by securing the line of communication, to facilitate the advance of an army or protect its retreat.

When a bridge is built across a river which runs through or along one side of a fortified town, the ramparts of the town in the one case, and those constructed for the defence of any buildings beyond the river in the other, may be considered as constituting the bridge-head; and then the works enter into the class of permanent fortifications. In other circumstances their form depends upon the nature of the ground, and upon the importance of the pass to be secured. If a retreating army is likely to be exposed to a serious attack when about to cross a river, the works must be strong enough to keep the enemy in check, and sufficiently extensive to contain the whole army, till the passage can be effected.

The simplest kind of bridge-head is one which has the form of a *redan;* that is, a breast-work, with two branches disposed on the plan like the sides of the letter A, and terminating on the bank of the river. But when a more perfect defence is required, the bridge-head may have the figure of a horn-work, or of a bastioned front; the area to be occupied by the defenders being inclosed, except at the gorge or river side, by the rampart or breast-work. When, however, the bridge-head is to be sufficiently capacious to serve as an intrenchment for the whole of an army, it may consist of a series of redoubts or redans flanking each other reciprocally, and disposed on a curve line whose extremities rest on the river; and whatever be the nature of the work, when its capacity is considerable, it is always advisable to have a redan or small fort immediately covering the bridge, acting as an interior retrenchment, with its faces so disposed that their fire may defend the intervals between, and flank the exterior redoubts. This retrenchment serves, after the main body of the army has passed over the river, for a small division acting as a rear-guard, to protect the retreat of the troops employed in defending the principal works. The passages by which an army or detachment, in retreating, enters a bridge-head consisting of a continuous parapet, should be situated in the re-entering angles of the work, if such there be, where they may be well flanked by crossing fires from the collateral faces; and they should be defended by a direct fire from traverses in the interior.

To prevent the enemy from advancing towards a bridge along the bank on which the works are situated, that bank, both on the right and left of the bridge, should be well defended by a fire of musketry or artillery; consequently the parapets adjacent to the river should be as near as possible perpendicular to its direction. And it is evident that the most favourable situation for a military bridge is at a bend of the river where the concavity is towards the enemy's position, for the fortifications will thus conceal the bridge from his view; and on either side of the work the brisures intended to defend the ground immediately in front may be directed towards the river, by which they will be secure from an enfilading fire of the enemy.

Should any commanding ground permit the enemy to direct a plunging fire of artillery upon the bridge or within the works, and should it be found impossible to give to the parapets a height sufficiently great to intercept that fire, batteries or redoubts must be constructed in convenient situations on the rear side of the river, in order by their fire to prevent the enemy from occupying that ground. Those works will also serve to defend the faces of the bridge-head when attacked; a traverse also should be raised on the same side of the river, perpendicularly to the length of the bridge, in order to enfilade the latter in the event of the enemy attempting to force a passage over it before it can be destroyed.

When there are islands in the river, it is advisable to establish the bridges so that they may connect the islands with the opposite banks, for thus the bridges, being shorter than if they were to extend quite across the river, may be more numerous, consequently the passage of the river will be facilitated and more effectually defended. There should be a separate bridge-head for each bridge, besides the general bridge-head on the farther bank; and any collateral islands there may be should be fortified, both to prevent the enemy from occupying them, and thus obtaining a view of the bridge, and to afford the means of flanking the principal bridge-head.

The most important bridge-heads in Europe are on the Rhine, at Ehrenbreitstein, Mannheim, Kehl, and Huninguen; all these have been celebrated in the wars of which the frontiers between France and Germany have so frequently been the theatre.

BRIDGE, MILITARY. Military bridges may be classed under the following heads: Pontoons; Boat; Rope; Boat and Rope; Cask; Trestle; Raft; Pile and Spar; Flying Pivot; Flying Trail.

Pontoon and cask bridges are described under Pontoon; flying pivot and flying trail bridges, which are in fact nothing more than ferries, under Flying Bridge.

Boat bridges are formed by an army, when unprovided with pontoons, from any small craft which can be collected on the river to be crossed; and when a bridge of this kind has to be formed in presence of an enemy, feints should be made at various points of the river, to deceive him as to the real place where, by a rapid movement, all the accessible boats are collected. Decked boats, as used for cargo, are the most adapted for the purpose; and in order to make good the irregularities in the heights of the various kinds, trestles are placed along their centres to carry the superstructure, the baulks of which should never rest on the gunwales. The bridge constructed over the Indus by Capt. G. Thomson, H. E. I. C. Engineers, which is described at page 92, vol. iv. 'R. E. Corps' Papers,' is an excellent example of boat bridges, for which no particular size and construction can be given, as they vary so much with circumstances and the *matériel* procurable.

Rope bridges are principally applicable for spanning the broken arch of a bridge, or for crossing a narrow river with steep banks. That constructed by Col. Sturgeon over the broken arch at Alcantara (in 1810), which spanned 100 feet, is an example both of method of construction and applicability of this material, where, as in this case, timber cannot be procured, or great portability is desired. Boat and rope bridges are often of great use. The bridge over the Adour, designed by Col. Sturgeon and executed by the Royal Engineers, is perhaps the best example ever constructed. The method of stretching the rope-work was much the same as that used at Alcantara, and will be found described in Sir H. Douglas's work on military bridges. The boats used were 48 *chasse-marées*, which were anchored stem and stern, to meet the run of the tide both ways, at first with one, but afterwards with two anchors, on account of the violence of the current. Trestle bridges are chiefly applicable to streams in mountainous countries, liable to sudden rises, and therefore often unfordable; and where the previously mentioned means are not procurable. The trestles are made of any rough timber, sufficiently high to carry the superstructure above any probable rising of the water, and are kept firm by being loaded with stones at the bottom, and by strong ropes or cables passed across and fastened to the tops. Sir H. Douglas mentions a trestle bridge constructed across the Agueda by Col. Sturgeon, which was 396 feet long, and carried on eighteen trestles.

Raft bridges are ill adapted to an army, as they are very unmanageable, especially when the passage is contested, and besides having little buoyancy, become waterlogged when kept long in the water. They have the advantage, however, where timber is plentiful along the bank of a river, of being made on the spot and requiring few skilled workmen, a few cables being the only *matériel* brought from the rear.

Pile and spar bridges are a more permanent description of bridge, though occasionally, when the stream is wide and deep, and the bottom suitable for pile-driving, they may be of great service to the military engineer.

For further particulars on this most important subject in military science, the student is referred to Sir Howard Douglas on Military Bridges, and the R. E. 'Aide Mémoire,' from which the above has principally been taken.

BRIDGES are of two classes, public and private. Public bridges may be considered either as county bridges or as highways, although the principle of that distinction does not seem very clear. Every county bridge is a highway, inasmuch as it is a bridge over which a highway passes; it is therefore in that respect strictly a highway: so also is every other public bridge over which a highway passes. The usual distinction drawn between them is derived from the nature of

the space over which the bridge gives a passage. A county bridge, or, in other words, a bridge which the county is bound to repair, is usually defined to be "a common and public building over a river or water flowing in a channel more or less definite; whether such river or channel is occasionally dry or not." This is evidently a very loose definition, for it does not prescribe the width of the river or the nature of its channel; but it seems clear that a county bridge must pass over a water, as the county would certainly not be bound to repair a bridge erected across a ravine, or over an ancient road crossed by a new road, having no reference to water. A county bridge may be either a foot, horse, or carriage bridge. A private bridge is any bridge which does not answer the description of a county bridge or a public highway. It is subject to no other laws than the general laws of property.

The liability to repair a county bridge depends either on the common law or on the statute law. By the common law the expense of maintaining both county bridges and highways is to be defrayed by the public, this having been part of the trinoda necessitas to which every man's estate was formerly subject. [TRINODA NECESSITAS.] But the burden of repair of county bridges is thrown on the whole county, that of highways on the inhabitants of the parish wherein such highways lie. Primâ facie, therefore, by the common law the whole county is liable to repair a county bridge; but they may rebut this presumptive liability by showing that for some reason or other the burden has been shifted from them on another. They may either show that a hundred, or a parish, or some other known portion of a county is by custom chargeable with the repair of a bridge erected within it; or that some person, individual or corporate, is liable to that expense. In the case of private individuals, such liability may depend either on tenure, that is, by reason that they and those whose estates they have in the lands or tenements are liable in respect thereof;—or on prescription. In the case of corporate bodies, on prescription only. With regard to corporate bodies, Lord Coke says, "If a bishop or prior, &c. hath at once or twice of almes repaired a bridge it bindeth not (and yet is evidence against him, until he prove the contrary); but if time out of mind they and their predecessors have repaired it of almes, this shall bind them to it." (2 'Inst.' 700.) Any bridge answering the definition above given of a county bridge may become a charge upon the county even though not originally built by the county; as, for instance, if it be built by the crown or a private individual: but not every bridge which answers the above definition is therefore chargeable to the county for repair, unless it be also used by and useful to the public. The public use and benefit seem to be the criterion: and if a private individual build a bridge of any sort, which is principally for his own benefit and only collaterally of benefit to others, he will be liable to the repair, and not the public: but where the public derive the principal benefit, they must sustain the burden of repairing it, on the ground that it would greatly discourage public-spirited persons from erecting useful bridges if they were ever after to be burdened with the costs of repair. The county are even liable to the repair of a public bridge erected by commissioners under an act of parliament, even though the commissioners are empowered to raise tolls in order to support it, or though other funds are provided for the repairs; unless there be a special provision for exonerating them from the common law liability, or transferring it to others. This common law liability of a county to repair a public bridge is so strong, that although it has been erected and constantly repaired by trustees under an act of parliament, and although there are funds for the repairs, the county are still liable to it. And where trustees under a turnpike act build a bridge across a stream, where a culvert would have been sufficient, but a bridge was better for the public, it was held that the county could not refuse to repair such bridge on the ground that it was not absolutely necessary.

The first statute on this subject is the 22 Henry VIII. c. 5, called 'the Statute of Bridges.' This statute is merely in affirmance of the common law. In course of time, owing to the indistinctness of the principle on which public bridges were divided into county bridges and highways, it was found expedient to pass an act to clear up the doubts and difficulties arising from this principle. In order, therefore, to ascertain more clearly the description of bridges hereafter to be erected, which inhabitants of counties shall and may be bound or liable to repair and maintain, it is enacted by stat. 43 Geo. III. c. 59, s. 5, that no bridge hereafter to be erected in any county at the expense of any individual or private person, body politic or corporate, shall be deemed to be a county bridge, unless it shall be erected in a substantial and commodious manner under the direction or to the satisfaction of the county surveyor, or person appointed by the justices of the peace at quarter-sessions to superintend and inspect the work. This act applies only to bridges newly built, and not to those repaired or widened.

It was found in very early times that many practical difficulties arose from the indistinctness of the common law as to the precise limits of a bridge—that is to say, as to the precise point where it ceased to be a bridge and began to be a highway; and vice versâ. This indistinctness gave rise to many disputes about the liability to repair, and it was found expedient to enact, by stat. 22 Henry VIII. c. 5, § 9, that such part and portion of the highways as lie next adjoining to the ends of any bridges within this realm, distant from any of the said ends by the space of 300 feet, be made, repaired, and amended as often

as need shall require; and that the justices of the peace should act respecting the repairs of such highways as they were empowered to act respecting the bridges themselves. The effect of this statute was merely to limit or fix the length of road which the county was to repair at 300 feet. By the common law the county was bound to repair the roadway at the end of every county bridge, but the length was not precisely determined till the passing of the above statute.

But this liability of the county has been very much narrowed by the stat. 5 & 6 Will. IV. c. 50, § 21 (the General Highway Act), which, with respect to bridges to be built after the 20th of March, 1836, enacts, "that if any bridge shall hereafter be built, which bridge shall be liable by law to be repaired by and at the expense of any county, or part of any county, then and in such case all highways leading to, passing over, and next adjoining to such bridge shall be from time to time repaired by the parish, person, or body politic or corporate, or trustees of a turnpike road, who were by law, before the erection of the said bridge, bound to repair the said highways: provided, nevertheless, that nothing herein contained shall extend to exonerate any county or part of any county from repairing the walls, banks or fences of the raised causeways and raised approaches to any such bridge or the land arches thereto."

Till late years no persons could be compelled to build or to contribute to the building of any new bridge, except by act of parliament; and even when the county was bound to repair a bridge, it was not therefore bound to widen it. Nor could the inhabitants of a county by their own authority change the situation of a bridge. But by the stats. 14 Geo. II. c. 33, § 1, and 43 Geo. III. c. 59, § 2, the justices in quarter-sessions are enabled to compel the county to widen or change the situation of old bridges, or build new ones. (See also 54 Geo. III. c. 90, which extends some of the provisions of those statutes.)

The 13 and 14 Vict. c. 64, provides that certain bridges which have been included within the boundaries of cities or boroughs, shall be repaired and maintained under the sole control of the council of such cities or boroughs.

The Railway Clauses Consolidation Act, 1845 (8 & 9 Vict. c. 20), contains various provisions as to the erection and maintenance of bridges over and under railways.

With respect to the appointment of surveyors of county bridges, their duties and powers, and the modes in which such powers are to be exercised, see stats. 22 Hen. VIII. c. 5, § 4; 43 Geo. III. c. 59 (coupled with stat. 5 & 6 Will. IV. c. 50); 54 Geo. III. c. 90; 55 Geo. III. c. 143. The provisions of these statutes are very numerous.

For the mode of taxing and collecting the moneys necessary for the repairs of bridges and the highways at the ends thereof, see stat. 22 Hen. VIII. c. 5; Anne 1, stat. 1, c. 18; 12 Geo. II. c. 20; 52 Geo. III. c. 110; 55 Geo. III. c. 143.

By the 4 & 5 Vict. c. 49, the justices at quarter-sessions may borrow money for repairing county bridges on the credit of the county rate.

In case of non-repair or nuisances, either to bridges or highways, the modes of prosecution are the same: namely, by criminal information, presentment, or indictment. Generally speaking, an action cannot be maintained against the county by an individual for the non-repair of a county bridge, unless in some cases of special damage accruing to such individual from the non-repair.

A criminal information is very rarely resorted to, and only in cases of either very aggravated neglect or where there seems to be little chance of obtaining justice by preferring an indictment.

The presentment of a public bridge for non-repairs, &c. may by common law be before the Queen's Bench or at the Assizes. By the stat. 22 Hen. VIII. c. 5, § 1, presentments may be made before the justices in general sessions, and they may proceed therein in the same manner as the judges of the Queen's Bench were in the habit of doing, "or as it should seem by their directions to be necessary and convenient for the speedy amendment of such bridges." See also for minor regulations respecting presentments, 1 Anne, sess. 1, c. 18; 12 Geo. II. c. 29, § 13; 55 Geo. III. c. 143, § 5.

The indictment of a county bridge is subject to the same rules as any other indictment. And though the whole county be liable to the repairs, any particular inhabitant of a county, or tenant of land charged to the repairs of a bridge, may be made defendant to an indictment for not repairing it, and be liable to pay the whole fine assessed by the court for the default of repairs, and shall be put to his remedy at law for a contribution from those who are bound to pay proportionable share in the charge.

The malicious destruction or damaging of public bridges is said to be punishable as a misdemeanour at common law, since it is a nuisance to all the king's subjects. By 7 & 8 Geo. IV. c. 30, § 13, it is enacted, "that if any person shall unlawfully and maliciously pull down or in any wise destroy any public bridge, or do any injury with intent and so as thereby to render such bridge, or any part thereof, dangerous or impassable, every such offender shall be guilty of felony.

(For further information see Lord Coke's *Second Inst.*; Burn's *Justice*; Russell *On Crimes*. For the law of bridges, viewed as highways, see WAYS.)

BRIEF (in law), an abridged relation of the facts of a litigated case with a reference to the points of law or evidence supposed to be applicable to them, drawn up for the instruction of the advocate who is to conduct the proceedings in court. Briefs vary in their particular

qualities according to the nature of the court in which the proceedings are pending, and of the occasion in which the services of the advocate are required; but in general they contain the names and descriptions of the parties, the nature and precise stage of the suit, the facts of the litigated transaction, the points of law intended to be raised, the pleadings, the proofs, and a notice of the case which may be raised on the other side.

BRIEF, commonly called CHURCH BRIEF or QUEEN'S LETTER. This instrument consisted of a kind of open letter in the royal name, and sealed with the privy seal, directed to the archbishops, bishops, clergymen, magistrates, churchwardens, and overseers of the poor throughout England. It recited that the crown thereby licensed the petitioners for the brief to collect money for the charitable purpose therein specified, and required the several persons to whom it was directed to assist in such collection. The origin of this custom is not altogether free from doubt; but as such documents do not appear to have been issued by the crown previously to the Reformation, they may possibly be derived from the papal briefs, which, from very early periods of the history of the Church, were given as credentials to mendicant friars, who collected money from country to country, and from town to town, for the building of churches and other pious uses. It is probable that, as soon as the authority of the pope ceased in England, these briefs began to be issued in the name of the sovereign. They appear to have been always subject to great abuse; and the stat. 4 Anne, c. 14, after reciting that "many inconveniences arose and frauds were committed in the common method of collecting charity money upon briefs," enacted a variety of provisions for their future regulation, and, among others, prohibited, by heavy penalties, the practice, which had previously prevailed, of farming briefs, or selling, upon a kind of speculation, the amount of charity money to be collected. Still these provisions were evaded, and heavy abuses arose; and the collection by briefs in modern times was found to be a most inconvenient and expensive mode of raising money for charitable purposes. ('Burns's Ecclesiastical Law,' tit. Brief.) The machinery provided by the statute of Anne was abolished by 9 Geo. IV., c. 42, which enacted "That, as often as his Majesty shall be pleased to issue his royal letters to the Archbishops of Canterbury and York respectively, authorising collection within their provinces for the purpose of aiding the enlarging, building, rebuilding, or repairing of churches and chapels in England and Wales, all contributions so collected shall be paid over to the treasurer of the 'Incorporated Society for promoting the enlargement, building, and repairing of churches and chapels,' and be employed in carrying the designs of the society into effect." This statute does not interfere with the authority of the crown as to granting briefs; Queen's letters have accordingly been issued till within the last few years; but they are now considered permanently abandoned.

BRIEF (PAPAL) is the name given to the letters which the pope addresses to individuals or religious communities upon matters of discipline. The Latin name is "brevis," or "breve," which in the latinity of the lower ages meant an epistle or written scroll. The French in the old times used to say "brief" for a letter, and the Germans have retained the word "brief" with the same meaning to this day. The difference between a Brief and a Bull in the language of the Papal Chancery is this: the briefs are less ample and solemn instruments than bulls, and are like private letters addressed to individuals, giving the papal decision upon particular matters, such as dispensations, release from vows, appointments to benefices in the gift of the see of Rome, indulgences, &c.; or they are mere friendly and congratulatory letters to princes and other persons high in office. The apostolical brief was formerly written on paper, but is now usually written on parchment; with the difference that the bull is written on the rough side in ancient characters, the brief is written on the smooth side in the modern characters; it is sealed in red wax with the seal of the Fisherman (*sub annulo Piscatoris*), which is a symbol of St. Peter in a boat casting his net into the sea. (Ciampini, 'Dissertatio de Abbreviatorum Munere,' cap. iii.) A bull is a solemn decree of the pope in his capacity of head of the Roman Catholic Church: it relates to matters of doctrine, and as such is addressed to all the members of that church for their general information and guidance. The bulls of excommunication launched by several popes against a king, or a whole state, are often recorded in history. The briefs are not signed by the pope, but by an officer of the Papal Chancery, called 'Segretario dei Brevi:' and they are indited without any preamble. The bulls are always on parchment, and sealed with a pendent seal of lead or green wax, representing on one side the heads of St. Peter and St. Paul, and on the reverse the name of the pope, and the year of his pontificate: their name comes from the Latin 'bulla,' a carved ornament or stamp. The bulls of indulgences are general, and addressed to all the members of the church; the briefs of indulgences are addressed to particular individuals, or monastic orders, for their particular benefit.

BRIEVE, a term once of much more frequent use in the law of Scotland than it is at the present day. It would appear that when the supreme civil court consisted of a committee of Parliament, permission to sue before that body was granted by brieve from the Chapel Royal of Chancery, containing the questions on which a decision or answer was required. It is now a writ, served by authority of the crown, directing an inquiry to be made by means of a jury, into certain matters specified. Of the inquiries conducted by brieves, the most important was, till lately, the brieve for service of heirs. This form was necessary for establishing the title of an heir in his ancestor's landed property. The brieve for this purpose was abolished by 10 & 11 Vic. c. 47. [HEIR.]

The brieves still known in the law of Scotland are:—the brieve of Tutory, by which an inquiry is made as to the person legally entitled to be tutor (guardian) to a pupil (that is a child under 14 years of age if a male, 12 years if a female), the brieves of Idiotcy and Furiosity, by which inquiry is made as to the question of a person's imbecility or insanity, before he is judicially deprived of the management of his affairs; the brieve of Terce, for establishing the right of a widow to terce (dower); the brieve of Division, dividing the lands of heirs portioners (coparceners).

BRIG, BRIGANTINE. [SHIP.]

BRIGADE. This term is generally applied, in military affairs, to the union of two or more battalions or regiments in one corps; but sometimes to the union of a certain number of men or guns in one subdivision. Thus from two to six battalions of infantry, or squadrons of cavalry, constitute a brigade. The British Rifle Brigade is composed of four battalions. The term brigade is also applied to a small party of Sappers consisting of eight men, which is divided into two demi-brigades of four men each, one demi-brigade only being employed in the execution of a trench by single sap. Six pieces of ordnance form a brigade of artillery. According to Père Daniel, commanders having the charge of several regiments, and the title of brigadiers, were instituted, in France, by Louis XIV. In the British service the commander of each brigade is entitled brigadier-general: his rank, which is only a temporary one while immediately in command, is immediately above that of colonel; and, to assist him in the performance of his duties, there is appointed a brigade-major, who is usually a captain, or if a subaltern, he holds in the brigade the rank of junior captain. An effective field-officer of a regiment is not eligible to this post.

The British army is not usually organised into brigades in time of peace except at the camps, but on active service the commanders of regiments make their reports to the brigadier-general; the latter transmits them to the general of the division, and through him they are communicated to the adjutant-general or to the commander-in-chief.

Not only the number of battalions which are united to form a brigade, but also the number of brigades which constitute a division, is various; both brigade and division depending upon the strength of the several regiments and upon the nature of the service. It may be sufficient to mention, that at the battle of Corunna, where the British army consisted of about 25,000 men under arms, the first line was formed of three divisions, the division constituting each wing consisted of three brigades, and the centre division of two; some of the brigades were composed of four battalions, some of two, and one of them of three. The infantry in the second line was, in like manner, unequally divided; the centre consisted of two brigades of cavalry, one formed of three regiments, and the other of two; and there were eleven brigades of artillery.

As the separation of an army into two or more principal divisions permits the greater changes of disposition in the line to be effected with a unity of design which is essential to their utility, so the secondary evolutions are accomplished with a corresponding advantage by the subdivision into brigades. The battalion being considered the unit of the modern tactical system, the brigade is the first multiple, the division the second, varying in numbers according to the exigencies of the service. The head of the army having communicated the general plan of the action to the officers who are immediately under him, relies on them for the execution of his plans, and is thus relieved from the necessity of following with his own eyes the movements of each particular battalion; while those officers, having the power of distinguishing themselves, either by a faithful adherence to the orders they may receive, or by the exercise of their judgment in modifying such orders according to the varying circumstances of warfare, are thereby prompted to display all their energies in making the necessary dispositions, and subsequently in animating the troops who are to execute them.

BRIGANTES, a tribe of ancient Britons who occupied that part of England which includes the counties of York, Lancaster, Cumberland, Westmoreland, and Durham, with the exception of the SE. corner of Yorkshire between the Humber and the sea as far as Flamborough Head, which was inhabited by the Parisii (Camden's 'Britannia'). The Brigantes first occur in Roman history under the reign of Claudius, when, having partially risen against the Romans during the war between the latter and the Iceni, they were defeated by the Prætor M. Ostorius, when some of their leaders were killed, and the rest submitted and obtained peace (Tacitus, 'Annal.' xii. 32.) During the civil wars of the empire, after Galba's death, the Brigantes revolted against their queen Cartismandua, who was an ally of the Romans, and who had forsaken her husband Venutius for a lover. Cartismandua escaped with great difficulty and by the assistance of some Roman cohorts, and Venutius remained master of the country of the Brigantes, and at war with Rome (Tacit. 'Hist.' iii. 45). Under Vespasianus the Brigantes were totally defeated by the Prætor Petilius Cerealis, after a severe struggle, and the Romans took possession of the greater part of

their country. Tacitus describes them as the most numerous tribe in the whole province of Britain ('Agricola,' xvii.) We find the Brigantes mentioned again under the reign of Antoninus Pius, when they made incursions into the neighbouring territory of Genunia (Pausan. viii. 43), which was subject to the Romans, for which they were attacked and defeated by Lollius Urbicus, and part of their territory was taken from them.

We find in Ptolemy a tribe of Brigantes in Southern Hibernia, between the rivers Birgus (Barrow) and Dabrona (Blackwater), occupying the space included in the modern counties of Waterford and Tipperary. They are supposed by some to have emigrated from Britain.

The Brigantes must not be confounded with the Brigantii, a tribe in Vindelicia, near the borders of the lake of Constance, whom Strabo (iv. p. 206, Causaub.) mentions as terrible robbers, whose name was the dread of the neighbouring countries, and who in their incursions into Italy used to commit the greatest cruelties, killing all the men and male children, and even the pregnant women. Whether it was from the traditional character of these Brigantii, or that the word itself meant in its original language marauders, or "free hands," as some have interpreted it, the name appears to have been held ever after in disrepute, and we find the French in the middle ages using the word Brigans as synonymous with armed adventurers. The English also used to say of a bold lawless fellow, "he plays the Brigans." (Camden.) In the wars of the French Revolution and of Napoleon, the appellation Brigands became common in the French invading armies to signify all those who resisted them without being regular soldiers, whom accordingly they did not consider as entitled to any of the courtesies of modern warfare.

BRIGHT'S DISEASE. [KIDNEYS, DISEASES OF.]

BRIMSTONE. The chemical relations of this important substance are treated under SULPHUR; but, as the Customs' authorities still employ the old-fashioned name of brimstone, we may briefly notice here the vast extent of the trade. In the three years 1856, 1857, 1858, the quantity of brimstone imported was as follows:—

1856	1,410,607 cwts.
1857	987,811 „
1858	1,156,476 „

averaging no less than 130 millions of pounds per annum. The chief employment is in the manufacture of gunpowder, ignitable matches, and sulphuric acid.

BRISTLES. The hog's bristles used in brush-making are brought in large quantities from Russia and Poland. As taken from the animal, they consist of various colours intermixed; but before use, and in some cases before importation, they are sorted by hand into the several varieties of colour termed in the trade black, gray, yellow, white, and *lilies*—the last-named of which are the lightest of all; but, excepting in the case of lilies, a bundle of any one of these kinds will be found to contain many shades or varieties of colour, which are carefully intermixed in the process of dressing whenever it is intended to use them together. In *dressing*, the bundle is repeatedly opened and combed with an instrument resembling a wool-comb; and, when a further separation of tints is not intended, the darker and lighter bristles are distributed as equally as possible among one another by separating and doubling the bundle. In all these operations the root-ends are carefully kept together, and in the dressing the bristles are separated into lots according to their length. If intended for fancy purposes requiring great neatness, the dressed hairs are subjected to the process of *picking*, which is frequently performed by children; in this process, every hair that differs much in colour from the mass is picked out by hand. Some bristles are also scoured or bleached, by which process they may be rendered almost perfectly white. Brush-making is the chief purpose to which bristles are applied; and the extent of some of the minor trades in this country is well illustrated by the fact that, in the three years ending with 1858, the average import of bristles was 2,500,000 pounds annually.

BRISURE, a term borrowed from the French and applied, in permanent fortification, to any part of a rampart or parapet which deviates from the general direction. Thus, in a front of fortification with retired flanks, the part of the curtain immediately contiguous to each flank, which is traced obliquely to the central part and in the direction of the produced face of the collateral bastion, is called the brisure of the curtain. An example of this kind of brisure is shown at *e* (*fig.* 1), in the article BASTION. In field fortification the faces of a star fort and of any indented line of parapet are called brisures.

BRITANNIA METAL, *Tutania*. An alloy of zinc, tin, copper, antimony, and lead, or bismuth in various proportions. The following are formulæ in common use:—

No. 1.		No. 2.	
Tin, Brass, Antimony, Bismuth,	of each equal parts.	Arsenic, Tin, Antimony, Bismuth, Brass,	of each equal parts.

The above alloys are to be added to melted tin till a specimen on cooling presents a good colour and proper degree of hardness for working.

No. 3.		No. 4.	
Tin	74·7	Tin	50
Lead	16·3	Brass	40
Antimony	4·5	Antimony	10
Brass	4·5		100
	100·0		

Nos. 3 and 4 require no farther preparation. Lead should never be present in larger quantity than 18 per cent., as even dilute vinegar would then quickly act upon and dissolve the alloy. Britannia metal is extensively used for the manufacture of such articles as coffee-pots, tea-pots, spoons, forks, &c. It is well adapted for these purposes on account of its silver-white colour; it also may be worked with considerable facility, and is susceptible of a high polish. The same care is necessary in the use of vessels made of this metal as of those made of copper, pewter, &c., namely that they be kept clean, and the access of acid substances prevented.

BRITISH GUM, *Dextrine, Starch Gum, Leicomene, Roasted Starch, Gum, artificial.*

A cheap substitute for gum arabic. The manufacture of this substance has lately been brought to a high state of perfection. It is obtained from starch by the action of dilute acids, diastase or heat.

To 1000 parts of starch are added 2 parts of nitric acid, diluted with sufficient water to moisten the whole mass. The mixture when dry is heated for two or three hours at a temperature of about 150° F., the heat being finally raised to 230° F.

To 400 parts of water heated in a copper to 85° F., 5 parts of crushed malt are added, and the mixture raised to 140° F., 100 parts of starch are now stirred in, and a temperature of about 150° F. maintained till the whole is changed into a viscous fluid. This usually occurs within half an hour. Immediately this state is arrived at, the heat is rapidly increased to 212° F. The diastase in the malt is thus prevented from converting the dextrine into glucose, or grape sugar: a transformation that would otherwise quickly take place. The liquid thus obtained is cleared by repose or filtration, and concentrated to a proper consistence by evaporation. The gum obtained usually contains small quantities both of starch and sugar, from which it cannot be freed without considerable trouble: their presence, however, is of little consequence for most applications of dextrine.

A third process, and the one most usually adopted, consists in simply heating the starch to a temperature a little above 300° F., till it assumes a buff colour, and is soluble in water.

British gum resembles gum arabic in all its common properties, and is used as a substitute in nearly all the applications of the latter, more especially to thicken the colours and stiffen the goods of the calico-printer, the dyer, and the paper manufacturer. It may be readily distinguished from the natural variety by the high power possessed by its solution of rotating a ray of plane polarised light to the right hand, hence the name "dextrine;" a solution of gum arabic rotating the ray to an almost equally powerful degree, but in precisely the contrary direction. Another test by which to distinguish these two gums from each other is to heat the aqueous solution over the water bath with caustic potash or soda, and a few drops of solution of sulphate of copper, when dextrine will cause a red precipitate of suboxide of copper, gum arabic not affecting the solution. Heated with strong nitric acid dextrine yields oxalic, and possibly succharic acids. Gum arabic under similar circumstances yields mucic acid.

Dextrine when pure has the same chemical composition as starch, namely, $C_{12}H_{10}O_{10}$. It is very soluble in water, less so in dilute spirit, and insoluble in absolute or tolerably strong alcohol. It is not coloured by iodine. Boiled with dilute acids it is converted into grape sugar. Subacetate of lead causes no precipitate in solutions of dextrine till ammonia is added, when a white compound falls, having the composition $C_{12}H_{10}O_{10}$, 2 Pb O. With protochloride of tin it also yields a precipitate, but none with sulphate of iron.

BRITISH MUSEUM, THE. The national museum of Great Britain, which comprises the national library, owes its origin to the will of a private individual. The founder, Sir Hans Sloane, was a native of Ireland, but of Scotch extraction, the son of a Scotchman who had emigrated to Ulster in the reign of James I. The greater part of his unusually long and fortunate life was spent in London, where for a quarter of a century he was president of the College of Physicians, as well as physician to the king, and succeeded Sir Isaac Newton as the president of the Royal Society. He died at Chelsea on the 11th of January, 1753, at the age of ninety-two. More than fifty years before he had acquired, by the bequest of his friend Mr. William Courten, an extensive and valuable museum of natural and miscellaneous curiosities, which he spent much of his time and fortune in augmenting. This collection, which had altogether cost him 50,000*l.*, he directed, by his will, to be offered to the British government for the sum of 20,000*l.*, which he stated to be in his belief not one fourth of the intrinsic value, and in case the offer should not be accepted on the part of the government within a twelvemonth, then in succession to the Academies of St. Petersburg, Paris, Berlin, and Madrid, for the same sum, with the proviso that in case of refusal by all these it should be disposed of for the benefit of his daughters. Fortunately

the proposal was at once accepted, and an Act of Parliament (26 George II. c. 22) secured the prize. The same Act of Parliament showed that a new spirit had been awakened in the legislature by providing for the purchase of the great Harleian collection of manuscripts for the sum of 10,000*l*. A few years before the great Harleian library of printed books, brought together by the same collectors, Harley the statesman Earl of Oxford and his son, had been allowed to be dispersed, to the irreparable loss of the national literature. The act directed also that the Cottonian library, which had become public property in 1700, apparently by donation from its proprietor, Sir John Cotton, should be added to the new establishment, which was to bear the name of the "British Museum."

Sir Hans Sloane had in his will named fifty persons whom he requested to act as trustees of his collection, and thirty other persons of high official rank and distinction, whom he requested to act as "Visitors," in the sense in which that word is used in connexion with the colleges at the universities, in which the Visitors have the right of examining into the observance of the statutes. The Act of Parliament made no appointment of visitors, but vested the government of the museum in a body of forty-one trustees, of whom six were family trustees, or representatives of the Sloane, the Cotton, and the Harley families; and twenty official trustees, as the Archbishop of Canterbury, the Lord Chancellor, the Speaker of the House of Commons, the Secretaries of State, and others, who were to elect the remaining fifteen in consideration of personal merits and fitness.

One of the first duties of this body was to consider where the new establishment should be located. Sir Hans Sloane had contemplated its conservation at the manor-house of Chelsea, which was included in the sale of the museum, but on consideration the trustees decided against this arrangement, and presented the manor-house to the family. Two mansions were offered the trustees for purchase—Buckingham House in St. James's Park, which afterwards became the Queen's House, and has since become the royal palace, and Montague House in Great Russell Street, immediately adjacent to Bloomsbury Square, at one corner of which Sir Hans Sloane had resided till at the age of eighty he relinquished his profession and retired to Chelsea. For Buckingham House, with its grounds and gardens, the price asked was 30,000*l*., and for Montague House, also with noble gardens covering seven acres and a half, little more than 10,000*l*. Montague House was selected, and the choice was a most fortunate one. At that time the building stood on the very outskirts of town, so much so indeed that the "fields behind Montague House" were still the favourite resort of duellists, and the view from the back windows stretched without interruption to the sister hills of Highgate and Hampstead, which bounded the horizon. It was nevertheless close to the main thoroughfare of Holborn, and to the Oxford Road, as Oxford Street was then called, and the only drawback to the advantage of the situation was that the wretched district of St. Giles's was in the immediate vicinity. In the century which followed, the open fields to the northward, eastward, and westward, were covered with miles of building, but this immense extension of the metropolis had the advantage of making the situation of the Museum more central. The new buildings in its immediate neighbourhood, forming the pleasant district called "the Squares," are of the tranquil and respectable character, best suited to the contiguity of a museum. The destruction of the old dens of St. Giles's, and the formation of New Oxford Street on their site, have placed it in the enviable position of standing in a quiet street, yet in the immediate neighbourhood of one of the most brilliant and crowded thoroughfares in London, and if the proposed continuation of Tottenham Court Road to Trafalgar Square be ever effected, it will be within a few minutes' walk of the point where two great thoroughfares from east to west, and from south to north will intersect each other.

The building which first received and for many years contained the British Museum was reputed to have been erected by a Frenchman, and was certainly adorned exclusively by French artists, a circumstance which gave rise to the popular but improbable notion, that the cost of it had been defrayed by the king of France. Ralph Montague, afterwards Baron and Duke of Montague, ambassador from James II. to Louis XIV., had about 1674 erected on the site a mansion of more than ordinary splendour from the designs of Robert Hooke, the mathematician, but in 1686, owing to the negligence of a servant the building was burned to the ground. It has been often stated that the architect of the new structure was Pierre Puget, of Marseille, eminent as a sculptor, painter, and both civil and naval architect, and that he was sent from Paris expressly to superintend it, but in the 'Biographie Universelle,' no mention is made of his having come to England, and the building bore no trace of the peculiar style which induced some to call him the French Michel Angelo. The new mansion was raised on the foundations of its predecessor. Towards Great Russell Street, it simply presented a sparingly ornamented brick wall, with an entrance in the centre surmounted by a small cupola, and with two peaked turrets at the ends. On passing through the gateway, the visitor found himself under an Ionic colonnade on one side of a large courtyard, on the northern side of which, immediately fronting him was the main building, a somewhat plain and unpretending edifice of brick, with stone dressings, 216 feet in length and 57 feet high, with a flight of steps leading up to the main door. On the two other sides of

the courtyard were the offices of the mansion, which, during the time of its occupation as the Museum, were appropriated to the residence of some of its officers. A view of the front on a large scale may be found in Strype's 'Survey of London,' for 1754. The visitor, who crossing the courtyard entered the building, found himself in a stately hall at the foot of the grand staircase, which was one of the most striking features in the interior architecture, and a representation of which is given in Ackermann's 'Microcosm of London.' Its walls and ceiling, and the walls and ceilings of all the principal rooms were adorned with fresco paintings by three French artists, Charles de la Fosse, Jacques Rousseau, and Jean Baptiste Monoyer, executed with admirable skill, and representing flowers and dead game, as well as several of the stories in Ovid's 'Metamorphoses.' The show rooms, twelve on the ground-floor, and as many on the first floor, were in general stately and well lighted, the front row looking on the courtyard, and the back on the garden. A ground-plan of the whole was published in Dodsley's 'London and its Environs,' in 1761, and another in Britton and Pugin's 'Public Edifices of London,' in 1823.

Such was the Museum, which after some years of preparation was opened for public inspection for the first time on the 15th of January, 1759. The establishment then consisted of three departments only, the printed books, the manuscripts, and the natural history. The earliest regulations for the admission of the public were extremely different from those now in force at the Museum, but they bear some resemblance to those which are still observed at the Soane Museum in Lincoln's-inn-Fields. It was provided by the regulations that "admission to such studious and curious persons who are desirous to see the Museum" should be obtained by means of "printed tickets, to be delivered by the porter upon their application in writing, which writing shall contain their names, condition, and places of abode, also the day and hour at which they desire to be admitted." This list was to be submittted every night to the principal librarian, or in his absence to another officer of the Museum, who, if he considered the parties admissible, was to "direct the porter to deliver tickets to them according to their said request, on their applying a second time for the said tickets," observing, however, that not more than ten tickets were delivered for each time of admission. The parties who produced these tickets were to be allowed three hours of inspection of the Museum, spending one hour in each department, and being taken in charge by a different officer for each, and the regulations for their reception are so detailed as to occupy about four pages octavo in Dodsley's 'London and its Environs.' How they operated in some cases may be learned from the account of a visit which was paid to the Museum by Hutton, the historian of Birmingham, in December 1784, and which he described in his "Journey from Birmingham to London,' published in the following year. Hutton, who had but a few days to stay in the metropolis, was unwilling to quit it without viewing the Museum, but "how to accomplish it was," he says, "the question. I was given to understand that the door, contrary to other doors, would not open with a silver key, that interest must be made some time before, and admission granted by a ticket on a future day. . . . By good fortune I stumbled on a person possessed of a ticket for the next day, which he valued less than two shillings; we struck a bargain in a moment and were both pleased." When he gained admission, he was hurried through the rooms, he tells us, in about thirty minutes by a surly conductor, who was both unwilling and unable to explain the curiosities, and he left in great dissatisfaction. "I had laid more stress," he says, "on the British Museum than on anything I should see in London. It was the only sight that disgusted me." The system which he thus described continued for many years longer, probably till 1803, when several alterations in the management took place. In the first 'Synopsis,' or official guide to the Museum, published in 1808, it is stated, that on the first four days of the week, 120 persons may be admitted to view the Museum, in eight companies of 15 each; but no mention is made of the necessity of their previously obtaining tickets. In the 'Synopsis' for 1810, a great advance appears. "According to the present regulation," it is stated, "the Museum is open for public inspection on the Monday, Wednesday, and Friday in every week (the usual vacations excepted), from ten till four o'clock, and all persons of decent appearance who apply between the hours of ten and two are immediately admitted, and may tarry in the apartments or the gallery of antiquities without any limitation of time, except the shutting of the house at four o'clock." From that period the regulations have been constantly growing more liberal, and the increase in the number of persons admitted in the course of a year is striking, though there has been some ebb as well as flow. The numbers in several twelvemonths, as given in the returns, are as follows:—

From May, 1807, to May, 1808 . . .	13,046
From March, 1817, to March, 1818 . .	50,172
From Christmas, 1827, to Christmas, 1828 .	81,228
From Christmas, 1837, to Christmas, 1838 .	266,008
From Christmas, 1847, to Christmas, 1848 .	897,985

In the year 1850, the numbers were just above a million; in the following, or "Exhibition year," when multitudes flocked to the Crystal Palace, the astonishing number of 2,527,216 was attained, a cipher surpassing that of the whole population of London. Since

then the amount has never risen to 700,000. In 1858 it was 519,565. The greatest number, however, that ever entered the Museum in one day was on the Boxing-day of Christmas, 1858, when there were upwards of 42,000. It is a circumstance that says much, that with this vast multitude of visitors, the only conspicuous act of destruction of the Museum property that has occurred was the act of a madman—the breaking of the Portland vase in 1845. The demeanour of the public in general has been excellent.

The Act of Parliament for founding the Museum had directed 100,000*l.* to be raised for the purpose by way of lottery, a method to which no objection appears to have been suggested in any quarter. Out of this sum, 10,250*l.* were paid to Lord Halifax for Montague House, and 12,873*l.* were expended in its repairs, which, characteristically enough, had been estimated in 1754 by three surveyors at 3800*l.*: 30,000*l.* were set apart as a fund for the payment of salaries, taxes, and other expenses. The salaries established at the outset appear on a very moderate scale indeed: the principal librarian received 212*l.* a year, the under-librarians for the three departments into which the Museum was divided 108*l.* each, and the assistant-librarians 69*l.* 6*s.* 8*d.* They continued apparently at this rate for about forty years; but a nearer examination shows that during most of that period the attendance of the officers was only given on two days in a week for two hours each time, and on three days in the following week for two hours each, and so by alternate weeks throughout the year; or, on an average, that the attendance of the officers was for five hours a week, instead of, at present, six hours a day. For any extra attendance they received extra compensation. No intention appears to have existed at first to make augmentations of the Museum to any considerable extent: according to a return made to the House of Commons in June, 1847, the amount of money expended in purchases in the year 1766 was only 2*l.* 8*s.* 6*d.*, and in 1768, 1*l.* 10*s.* 6*d.*, in each case for additions to the department of printed books. The sums expended did not continue so excessively low as this; but only on five occasions during the forty-one years which elapsed from the opening of the Museum to the close of the 18th century is the regular annual expenditure of the Museum on purchases recorded to have exceeded 400*l.*

With the beginning of the 19th century the character of the Museum began to change, and, gradually, from a stationary it became an eminently progressive institution. The adoption of the more liberal system of admission, both to the Museum in general and to its reading-room, appears to have given an impulse to improvement by arousing the interest of the public in its welfare, and thus favouring the application to the legislature for grants for its increase. The votes for purchases began to grow perceptibly larger towards the conclusion of the reign of George IV., and after the passing of the Reform Bill. For the ten years which ended in 1806, the total given in the return to the House of Commons, in 1847, is 4401*l.* 8*s.* 8*d.*; for the ten years to 1816, 78,173*l.* 18*s.* 1*d.*; but this is evidently swelled by the grant of 35,000*l.* for the Elgin Gallery, the largest grant for a purchase the Museum has ever received. In the ten years to 1826, the total had again sunk to 30,583*l.* 5*s.* 5*d.*; in those to 1836 it rose to 49,434*l.* 11*s.* The average of the grants in the succeeding ten years was over 16,000*l.* a-year. In the estimates for 1859, the amount proposed to be granted for purchases and acquisitions is 21,955*l.*: of which 10,000*l.* are for the Printed Book Department; 2550*l.* for that of Manuscripts; 820*l.* for the Minerals; 820*l.* for Geology; 1525*l.* for Zoology; 175*l.* for Botany; 3050*l.* for Coins and Antiquities; 2115*l.* for Prints and Drawings; leaving 1000*l.* for freight and carriage.

Many of the great purchases of the Museum have been effected by special grants, which will be found recorded in the outline of the history and state of the separate departments which follows this sketch of the general history of the establishment. We will now pursue the history of the building.

Large acquisitions of antiquities in 1801 and 1805 led to the establishment of a separate department of antiquities in the Museum, and to the erection of a new edifice of thirteen rooms in the gardens to receive the new treasures. This building, which communicated by a passage with old Montague House, was of an entirely different architectural character, and offered to the London public for the first time a series of classical saloons suited to the idea of a Museum. It was opened in 1807, and did credit to its architect, Mr. Saunders. The subsequent acquisition, in 1816, of the Elgin marbles, which were for some years exhibited in a wooden shed, rendered familiar the contemplation of further extension of the building; and the presentation of the library of George III. in 1821 made it imperative to provide a suitable room for its reception, which was one of the conditions of the gift.

The design for the King's Library, which was prepared on that occasion by Sir Robert Smirke, the architect of the Museum, formed part of a general design for rebuilding the whole Museum, involving the demolition not only of Montague House, but of the saloons for the department of antiquities constructed by Mr. Saunders. Sir Robert's proposals were adopted by the Trustees and in the course of the twenty-five years from 1823 to 1847 were carried into execution. In place of the former brick wall in Great Russell Street a splendid partially-gilded railing now allows the passenger to survey the magnificently enriched front of the new edifice, presenting a recessed portico and two projecting wings, each clothed in Ionic columns, the

whole forming a forest of columns forty-four in number, which from fronting to the south have a play of light and shade such as no other portico in London presents. On each side, a range of officers' houses encloses the court-yard, through which the visitor proceeds to the principal entrance, where, as before, he finds a spacious hall, with, on the left-hand side, the principal staircase. The building erected by Sir Robert Smirke consists of four ranges of apartments,—east, west, north, and south,—which enclose a hollow square or large open quadrangle in the centre. The eastern range, which was built and in use some years previous to the gradual erection of the others, contains some apartments appropriated to the manuscript collection, and also the Royal Library, a magnificent apartment 300 feet in length and 40 wide, with inlaid floor and coffered ceiling. The northern range of apartments, is allotted to the general library, and is less ornate in appearance than the eastern range, but contains one room called "the Main Library," of the dimensions of 84 feet by 80, which is of a striking character. The western range, erected partly on the site of Mr. Saunders's building, presents one large apartment 300 feet in length, appropriated to Egyptian and other sculpture. The southern range, which was the last to be completed, occupies the site of old Montague House, and contains the great hall and staircase, to which we have now returned by performing the circuit of the building, with to the east of the hall a room containing the Grenville library, and to the west of the hall a saloon containing antiquities. The whole of this long extent of building on the principal floor is of the height of 31 feet, lighted by large windows, which are at the height of nearly 14 feet from the floor. Its general character is classical, and its features almost invariably square or oblong, the arch and circle being apparently avoided with care throughout; and from the height of the windows, which are in some cases flanked by columns outside, there is in some portions a deficiency of light. The less important range of rooms on the floor above is lighted invariably by skylights, an arrangement which allows more wall-space for the exhibition of objects. Commencing with the eastern range, as in the case of the floor below, we first find a long gallery of the same dimensions, except in height, as the Royal Library, over which it stands. This room was originally designed by Sir Robert Smirke for the reception of the National Gallery of pictures, but was never used for that purpose, having first been appropriated to the mineralogical, and afterwards, as it is now (in 1859), to the ornithological collection. The rooms in the other three ranges of building are all much of the same character, and in no instance of very large dimensions; they are all fitted up with plain glass cases against the walls and in the middle for the exhibition of the objects they contain,—the mineralogical and part of the natural history collection in the northern range, the antiquities in the western and in the division of the southern gallery to the west of the great staircase, while the botany occupies the division to the east. The ranges of apartments on this floor, while of good dimensions and not unornamental, can hardly be considered as advancing any pretensions to high architectural character.

Such is the great edifice of Sir Robert Smirke, which, even if it stood thus without any additions, might yet claim to be the first in importance and splendour of the unecclesiastical edifices of the British metropolis, with one exception which was not in existence or contemplation at the time his design commenced—the Houses of Parliament. But even before the grand square had slowly worked its way to completion, it was discovered that the space its apartments afforded was insufficient for the continually increasing needs of the Museum. A gallery or saloon for the Elgin marbles was constructed by erecting a fresh building to the west of the western range, and other similar rooms for the reception of other collections have since been added communicating with it. Further accommodation for the library was procured by building what is called "the Arch-room," in continuation of the northern wing towards the west. In this case the wishes of the librarian, as well as the architect, were taken into consideration, and the result was gratifying even in an architectural point of view. Room for books was gained by a second gallery on arches, and additional light by the insertion of a large arched window in the principal floor, the only window on that floor which the building contains. The visitor who stands at the point where the eastern and northern ranges of building intersect, and first surveys in one direction the long array of 300 feet of glazed book-cases in the Royal Library, meets, as he turns in the other direction, the flood of light from the great window, at the end of the long perspective of more than 450 feet of book-filled recesses, which stretch from one end to the other of the northern range. These improvements owe their origin to the librarian, Mr. Panizzi; and to him is due also the suggestion of an additional room for books at the eastern or exterior side of the King's Library,—a room which, though only of half the height and half the breadth of that beside which it stands, and thus only a quarter of its dimensions, was finally adapted by an economical disposition of its space to receive fully the same number of volumes. When even all the room thus gained had been appropriated, and more was still wanting for the library, which began to overflow into the basement, a serious question arose, of how to provide space for the increase of the Museum. Some discussion has arisen as to the priority of suggestions on the subject, and Mr. Hosking, an architect, who published a pamphlet of Observations on the Reading-room' in 1858, assigns the earliest notion

of building in the hollow square or quadrangle of the main building to Mr. Edward Hawkins in 1842; but the idea will be found in a series of letters on the Museum, which were published anonymously in the 'Mechanics' Magazine' for 1836 and 1837, but have since been acknowledged by Mr. Watts, now one of the officers of the Printed Book department. "The space thus unfortunately wasted," says Mr. Watts, speaking of the quadrangle ('Mechanics' Magazine,' vol. xxvi. p. 457), "would have provided accommodation for the whole library. A reading-room of ample dimensions might have stood in the centre, and been surrounded on all four sides by galleries for the books communicating with each other and lighted from the top." "Perhaps the best plan," he suggests, in another part of the same paper, "would be to design another range of building entirely inclosing the present at the eastern and northern sides, as the Elgin gallery, &c., do on the west." Each of these plans was proposed many years after to the Lords of the Treasury by the trustees of the Museum; but that of encircling the present Museum with a belt of additional buildings would of necessity have required the demolition of the ranges of valuable private houses which at present occupy the site; and as the expense of thus clearing the ground was estimated at a quarter of a million, the plan was rejected as too costly. In 1852, and again in 1854, Mr. Panizzi proposed the plan of covering the quadrangle, which was at length adopted, and in the very centre of the Museum now rises a reading-room of truly "ample dimensions, surrounded on all four sides by galleries for the books, lighted from the top."

The new reading-room is now one of the principal architectural features of the Museum, and is the only one that is visible at a distance, the dome that crowns it forming part of the view of London from Hampstead Heath, and from the Norwood hills near the Crystal Palace. The approach to the room from the entrance hall of the museum is by a long passage, which is adorned with a bust of Mr. Panizzi by Marochetti,—an excellent likeness,—the result of a subscription proposed by Mr. Winter Jones, the present keeper of the printed books. On crossing the threshold the visitor finds himself in a large circular apartment crowned with a dome of the most magnificent dimensions, the largest indeed, with one exception, in the world. The diameter on the floor is 140 feet, the height from the floor to the top of the dome 106 feet; while the Pantheon at Rome, the room which it most resembles, is 142 feet in both dimensions, the drum or cylindrical portion rising to half that height before the arch begins to spring. It is contended by Mr. Hosking, who proposed in 1848 to erect on the same spot a hall for the reception of antiquities, of the exact proportions of the Pantheon, but on a reduced scale, that this departure from these proportions destroys the beauty of the reading-room; but the general opinion appears to be rather one of regret that the architect of this portion of the Museum, Mr. Sidney Smirke, did not increase his dimensions by a few feet; so that the dome, which surpasses in size that of St. Peter's at Rome, and of course its nearer neighbour St. Paul's of London, might, surpassing that of the Pantheon also, be indisputably the largest in the world. Several who have seen both buildings declare that the reading-room, as it is, produces the impression of being the larger of the two, and its arch of blue and gold gives it much the superiority in richness and lightness. Instead of the somewhat monotonous diminishing squares of the Pantheon dome, a range of twenty lofty windows, 27 feet high and 12 feet wide, run round the circle of the reading-room, and in conjunction with a lantern light of 40 feet diameter at the crown of the arch, pour a flood of light below. Under the windows the room presents a continuous circular wall of books, 25 feet high. They are disposed in presses or bookcases, accessible from the floor, or from low galleries running round the apartment, and comprise in the part open to the readers, about 20,000 volumes of books of reference and standard works, and in the part round the galleries more than 50,000 volumes of the principal sets of periodical publications, old and new, in the English, French, Italian, Spanish, German, Danish, Swedish, Dutch, Russian, Polish, Bohemian, Hungarian, Welsh, Latin, Greek, and Hebrew languages: a collection already more rich and varied than was ever before assembled under one roof, and receiving daily increase. The floor of the room is occupied with 19 large and 16 smaller tables, fitted up with ample accommodation for more than 300 readers; but, by the simple expedient of raising the partition down the middle of each of the larger tables so high that a reader cannot see his opposite neighbour, so much privacy is produced that on entering the room when it is quite full a stranger might at first suppose that it was nearly empty, and no seated reader sees more than three or four of his fellow-readers at a time. The tables are all arranged so as to converge towards the centre of the room, and near the centre are the two circular ranges of stands for the catalogue, a portion of which is thus actually at the end of every table. Directly in the centre is the table of the chief superintendent of the reading-room, a duty at present assigned to Mr. Watts, the assistant keeper of the Printed Books, who has already been mentioned as having first suggested the idea of a central reading-room. From his position, and still more from the galleries, an interesting view is commanded of all the tables and their occupants, often between two and three hundred in number, and comprising among them some of the best known names in the world of literature and learning—names that are familiar now to all the readers of Europe and America, and will be familiar in all probability centuries hence, from the very labours in which they are aided by the Museum reading-room. From the nature

of the library around them, not only such men as Carlyle and Thackeray, Kossuth and Montalembert, but the humblest labourer in the literary vineyard, from the most distant corners of the world, may be certain that on the walls around there exists some record of his labours, or the copy of some lines traced by his hand. The name of Mr. Panizzi will be inseparably connected with this, the most magnificent temple ever erected to literature, which, without his powerful influence, would probably never have existed.

The reading-room and the new library which surrounds it are constructed almost entirely of iron and brick, to guard against the danger of combustion. Even the shelves, which it is estimated will extend to about twenty-five miles in length, are partly constructed of metal. Beneath the room is a large array of pipes for heating the room in cold weather with warm water, and there are ingenious contrivances for cooling it when required. The expense of the new reading-room and its appurtenances, including the new library around it, which is to afford space for more than a million of books, amounted at the time of its being opened to the readers, on May 18th, 1857, to 150,000*l*.

All the available space under the control of the Museum being now occupied with buildings, and a strong demand still existing for space for the extension of the departments of antiquities and natural history, the question is again under consideration how this domand is to be met—whether by an extension of the present edifice, or by removing some portion of the contents of the Museum to another locality. A copy of communications made by the officers and architect of the British Museum to the trustees, respecting the want of space, was laid before the House of Commons in March, 1859. The plan at present in contemplation is understood to be that proposed by Mr. Panizzi so early as 1836, of removing the whole of the departments of natural history to some other spot, and thus allowing space for the growth of the antiquities. There is a precedent in the history of the Museum for the transfer of a portion of its property to the custody of another institution, while still retaining it under the control of the trustees. Sir George Beaumont's pictures, given by him to the Museum, are still the property of the Museum, though preserved in the National Gallery. Whatever may be the decision arrived at, it appears probable that the Museum is on the eve of another change, as important as any it has undergone.

While in other respects the Museum has witnessed so many alterations, it is remarkable that the constitution and character of its governing body remain after the lapse of more than a century nearly the same as at its origin. The Board of Trustees consisted of forty-one members,—it now, by gradual additions of official and family members, consists of fifty. The power of patronage, or of nomination to the different posts of the Museum, with the exception of that of principal librarian, is vested by act of parliament in the hands of the three principal trustees, the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons. There are twenty-two other official trustees, the Lord President of the Council, the First Lord of the Treasury, the Lord Privy Seal, the First Lord of the Admiralty, the Lord Steward, the five principal Secretaries of State, the Bishop of London, the Chancellor of the Exchequer, the Lord Chief Justice of the Queen's Bench, the Master of the Rolls, the Lord Chief Justice of the Common Pleas, the Attorney- and Solicitor-General, the Presidents of the Royal Society, of the College of Physicians, of the Society of Antiquaries, and of the Royal Academy. Since 1832 one trustee is appointed by the sovereign, and this post which remained vacant for years after the death of the Duke of Cambridge in 1851, was filled up in 1859, by the Queen's appointment of the Rev. William Cureton, who from 1837 to 1850, was the assistant-librarian of the Manuscript department. Of the family trustees, two are representatives of the Sloane, two of the Cotton, and two of the Harley family, one of the Townley, one of the Elgin, and one of the Payne Knight family; the Earl of Derby and the Earl of Elgin are at present two of the number. The fifteen elected trustees are chosen by the other members of the board, and to attain this honour has been called "the blue riband of literature." The list of them offers the names of many illustrious persons, and in particular of many eminent benefactors to the Museum. Dr. Birch, and Sir William Musgrave, the Rev. Clayton Mordaunt Cracherode, Mr. Tyrwhitt, Sir Joseph Banks, Sir George Beaumont, and the Right Hon. Thomas Grenville, all bequeathed important donations to the Museum, and several made presents of value during their lifetime. The list of the fifteen elected trustees is at present as follows: the Earl of Aberdeen, the Marquis of Lansdowne, the Duke of Sutherland, Lord Macaulay, Sir David Dundas, Sir Philip Egerton, the Duke of Somerset, Sir Roderick Murchison, the Very Rev. H. H. Milman, Dean of St. Paul's, Lord John Russell, the Right Hon. William Ewart Gladstone, Sir George Cornewall Lewis, the Right Hon. Spencer Walpole, Viscount Eversley, and George Grote, Esq. The business of the Museum is laid before a standing committee of the trustees, consisting of the three principal trustees, and of fifteen others selected from among themselves by the main body.

At two different periods the management of the Museum by the trustees has been made the subject of public inquiry,—by a committee of the House of Commons, moved for by Mr. Hawes in 1835-36, and by a Royal Commission presided over by the Earl of Ellesmere in 1848-49. On each occasion the body of evidence taken occupied about

eight hundred printed folio pages, and the four volumes of Blue Books which embody the reports are undoubtedly the most valuable of existing storehouses of information on the Museum. It is to be regretted, however, that much of the evidence relates to personal matters only, and that several points of the management of the Museum on which light would be welcome to the public were left in darkness. The committee of 1835 recommended several alterations in the management of the Museum, some of which were adopted by the trustees, who, in 1837, laid before the House of Commons a series of extracts from their minutes, to show how far they had complied with these suggestions. The committee also strongly recommended increased liberality to the institution on the part of the House of Commons; a recommendation which appears to have borne its fruits, for from that time to the present the spirit of the House of Commons has been evidently in favour of the Museum, and has rather encouraged than repressed proposals for the extension of the national collection on the part of the trustees and the Treasury. The Royal Commission was nominated to inquire into the whole management of the Museum, but brought its labours to an unexpected close after an inquiry almost confined to the Printed Book department, and chiefly directed to the questions connected with the Catalogue. The commissioners stated their wish that no change should take place in the Board of Trustees, but that an Executive Council, to be composed of a chairman, four members elected by the trustees, and two named by the crown, the chairman and the two royal members receiving a salary, should be entrusted with the whole patronage and management of the Museum. No measure founded on this report has, however, been submitted to the legislature. In the present year, 1859, a proposal for a committee of the House of Commons on the Museum was brought forward by Mr. Gregory, the member for Galway, and acceded to by the Earl of Derby's government, but had not yet passed through the necessary forms when parliament was dissolved. It was chiefly intended to inquire into the expediency of removing the natural history collections from the Museum.

The Principal Librarian is the name assigned to the chief officer of the Museum, in the Act of Parliament which founded it, and the name is still continued, although his duties have no connexion with the library more than the other departments, all of which, without exception, are under his superintendence. The principal Trustees nominate two persons for this appointment, one of whom is selected at pleasure by the sovereign. The first principal librarian was appointed in 1756, and the sixth in 1856, exactly a century after, giving twenty years as the average term of tenure. It is remarkable that, from the first establishment, the office has been alternately held by an Englishman and a foreigner. The list is as follows :—

1. Gowin Knight, M.D., 1756-1772;
2. Matthew Maty, M.D., a Dutchman, 1772-1776;
3. Charles Morton, M.D., 1776-1799;
4. Joseph Planta, a Swiss, 1799-1827;
5. Sir Henry Ellis, K.H., 1827-1856;
6. Antonio Panizzi, an Italian, 1856 (the present principal librarian).

Little is known of Dr. Gowin Knight, the first chief officer, whose claims to the appointment prevailed over those of Sir John Hill, the botanist, an eager candidate for the post. Some notices of him are to be found in Nichols's 'Literary Anecdotes.' His successor, Dr. Maty, had come to England, in 1740, at the age of twenty-two, but published, in Holland, for some time after, a periodical in the French language, containing an account of English literature, the 'Journal Britannique;' and Gibbon, who was a contributor, says, that the "humble though useful labour" of a reviewer "was not disgraced by the taste, the knowledge, and the judgment of Maty." He was appointed one of the under-librarians of the Museum at its first institution in 1753, and when, after nearly twenty years' service, he succeeded to the principal librarianship, much was expected of him, but the hope was frustrated by his early death in 1776. His successor, Dr. Morton, who like both his predecessors had practised as a physician, had also been an under-librarian of the Museum from before its opening in 1756, and he held the appointment till his death in 1799, at the age of eighty-three. He was author of a paper in the 'Philosophical Transactions' on the supposed resemblance between the Egyptian hieroglyphics and the Chinese character. Lives both of Dr. Maty and Dr. Morton are to be found in Chalmers's and the usual biographical dictionaries. The fourth principal librarian, Joseph Planta, was born in the country of the Grisons, in 1744, and came to England, in 1752, with his father, the Rev. Andrew Planta, who was minister of the Reformed Church in London, and tutor in Italian to Queen Charlotte, and who, in 1758, became an assistant-librarian at the Museum. The son was intended for a diplomatic career, but on the death of his father, in 1773, succeeded to his post at the Museum, and continued there from 1773 to 1827, holding, also like both his predecessors, a post in the Royal Society. He published a 'History of the Helvetic Confederation,' abridged from Johann von Müller, and a dissertation, in the 'Philosophical Transactions,' on the Romansh language, spoken by the Grisons. The largest biography of him we have seen was written by Falkenstein, the librarian of Dresden, and published in the German periodical, the 'Zeitgenossen.' He was succeeded by Mr., afterwards Sir Henry, Ellis, the circumstances of whose appointment are curiously illustrated by some passages in the published life of Fynes Clinton, whose name was sent up to the king with that of Sir Henry, by the then principal trustees, in accordance with the rule, that two names are to be submitted to the sovereign for the vacant post of principal librarian. Sir Henry is the author and editor of numerous volumes, from the 'History of Shoreditch,' in 1798, to the 'Pilgrimage of Sir Richard Guilford,' in 1851, and, among others, of some volumes on the Townley marbles, and also on the Elgin and Phigaleian marbles in the Museum, published in the 'Library of Entertaining Knowledge.' When he retired from the chief librarianship in 1856, he had been fifty-one years an officer of the establishment, having, in 1805, succeeded the Rev. Samuel Ayscough as assistant-librarian. His acquaintance with the Museum had commenced even previously, Sir Henry having been in 1795, as he still is in 1859, a frequenter of the reading-rooms. The united experience of the third and fifth principal librarians is thus seen to extend over the whole history of the Museum, from its commencement to the present time, a period of more than a century.

Mr. Panizzi is well known as the editor of Boiardo and Ariosto, to whose two poems united he prefixed an admirable essay on the narrative and romantic poetry of the Italians. Even in the present year, 1859, he has added to his labours on Italian literature by the publication of a collation of the four first editions of Dante, with a bibliographical preface. He entered the Museum in 1831 as extra assistant-keeper of the printed books, and in 1837 was appointed keeper of the department, a post which he filled for nineteen years with remarkable efficiency. Previously to his engagement at the Museum, he was professor of the Italian language and literature at the present University College, then called the London University.

The next most important office to that of the principal librarian is that of secretary to the trustees, which was held separately by the Rev. Josiah Forshall from 1837 to 1849, when he resigned, and the office has since been held by the principal librarian.

The Museum is at present divided into eight departments, under separate officers :—the Departments of Printed Books, of Manuscripts, of Antiquities, of Prints and Drawings, of Zoology, Geology or Palæontology, Mineralogy, and Botany. To each of these departments, there is a chief officer called a Keeper; to those of Natural History there is also a newly-appointed superior officer, who bears the name of superintendent. The departments are of very different extent and importance : the keeper of the Printed Books has under him two assistant-keepers, twenty-five so-called "assistants," who are gentlemen of education and acquirements, chiefly employed in making the catalogue, thirteen transcribers, and more than forty attendants; while the keeper of the prints and drawings has but one transcriber and two attendants, and the keeper of the mineralogy one attendant only. In the earlier stages of the Museum history the officers were often removed from one department to another, a practice which renders it desirable to say what is to be said on the biography of the most prominent officers in connection with the general history of the institution, rather than with that of the separate departments. One of the earliest officers, as keeper of the natural history department, was James Empson, who had been in Sir Hans Sloane's lifetime, keeper of his museum. The name of Dr. Solander, a Swede, who had accompanied Sir Joseph Banks in his voyage round the world, and who was assistant librarian and then keeper, between 1765 and 1782, the date of his decease, is preserved in perpetual remembrance by his invention or contrivance of "Solander cases," a kind of easily manageable box in the shape of a volume which is useful for the preservation of unbound pamphlets. The Rev. Charles Godfrey Woide, a Prussian, an assistant librarian (1782-91), edited with much care the New Testament, from the Alexandrian Codex, hereafter to be mentioned, a peculiarly valuable manuscript of the Scriptures preserved in the Museum. The Rev. Henry Hervey Baber, who entered as assistant librarian in 1807, and became keeper of the printed books in 1812, completed the undertaking by editing the Old Testament portion of the Alexandrian Codex; and was finally rewarded for doing so by the presentation of a valuable living in the country, to which he retired in 1837, resigning his post at the Museum. The Rev. Samuel Ayscough had been for some time in the employment of the Museum, when in 1787 he was appointed to an assistant librarianship, which he retained till his decease in 1805. Mr. Ayscough seems to have had a peculiar pleasure in making indexes and catalogues. He compiled the consolidated indexes for the sets of the 'Monthly Review,' the 'British Critic,' and the 'Gentleman's Magazine,' and the index to the remarkable passages and words in Shakespere, which was the completest concordance to Shakspere, till that of Mrs. Cowden Clarke. He made, in 1782, the catalogue of the manuscripts at the Museum, belonging to the Sloane and Birch collections, a book far from correct, but still of use till supplanted by a better. He also assisted in the compilation of the catalogue of the printed books of the Museum, published in 1787, in two volumes folio, of which the other portions were taken by the Rev. S. Harper—assistant librarian from 1756, and keeper from 1765 to 1803—and the Rev. Paul Henry Maty, a son of Dr. Maty, who like Planta, entered the Museum on the death of his father, and only survived till 1787, the year of the publication of the catalogue. Andrew Gifford, D.D., assistant keeper of the manuscripts from 1756 to 1784, was remarkable for having at his decease, bequeathed to the Baptist Library at Bristol, several rare printed books, including a copy of an edition of Tyndale's Testament,

absolutely unique, and which could not have found a more appropriate resting-place than the British Museum. Dr. Edward Whitaker Gray, M.D., assistant and afterwards keeper of the natural history (1778—1807), was a relative of Dr. John Edward Gray, the present keeper of the zoology; Dr. Gray's successor in the keepership was Dr. George Shaw, a well-known writer, whose 'Naturalist's Miscellany,' and 'General Zoology,' are still referred to. In 1803 to 1806 the Rev. William Beloe, author of the 'Sexagenarian,' was keeper of the printed books, and one fruit of his connection with the Museum was his six volumes of 'Anecdotes,' in which he gives somewhat dry particulars of many books in the library, especially of those in the Cracherode collection. While the Rev. Samuel Ayscough was index-maker to the 'British Critic,' the Rev. Robert Nares was editor, and figured not only as a writer but a novelist, in 'Thinks I to Myself, Thinks I.' He was assistant in 1795, and rose to be keeper of the manuscripts in 1799, on the promotion of Planta, but resigned the office in 1807, on being appointed to an archdeaconry. His successor in the manuscript department was Francis Douce, the antiquary, who only held it till 1812, when, taking offence at some circumstances of his position, and being in possession of a good private fortune, he resigned, and at his decease, in 1834, left his valuable library to increase the stores of the Bodleian. The Rev. Thomas Maurice, "the author of 'Indian Antiquities,'" as he delighted to style himself, entered the Museum as assistant librarian in 1799, at the promotion of Nares, and remained unpromoted till his decease in 1824. Among his numerous works he had commenced an autobiography, which contains some agreeable gossip, but does not come down to the time of his connection with the Museum. Mr. Taylor Combe, who entered in 1803 as assistant librarian, became in 1807 keeper of the new department of antiquities, which was founded, as already mentioned, in consequence of large additions, and installed in a new building. He held the office till 1826, when, by his unexpected demise, Mr. Edward Hawkins, who had only entered the Museum that year, at once mounted to the keepership. Mr. William Alexander was, from 1808 to 1816, keeper of the prints, which then formed a portion of the department of antiquities. He had accompanied Lord Macartney in his embassy to China, and his published views in China testify to his skill as a draughtsman. His successor, Mr. John Thomas Smith, from 1816 to 1833, was the author of the amusing volumes entitled 'Nollekens and his Times,' and many other works of less note. The next keeper of the prints was Mr. William Young Ottley, whose works on early engravings are still the first referred to in any question on the history of the art.

Mr. Charles König, an accomplished German, who entered as assistant in 1807, and was promoted in 1813, continued keeper of the mineralogy till his death in 1851. He had been one of the Banksian librarians, and continued united in friendship with Mr. Robert Brown, who came to the Museum in 1827 as head of the Banksian or botanical department. Mr. Brown was recognised by foreigners as well as Englishmen as the first botanist in Europe. Humboldt styled him "Botanicorum facile Princeps," and his works are perhaps better known in Germany than in England. Mr. John George Children, who was assistant librarian in 1816, and in 1837 became keeper of zoology, was the friend of Sir Humphry Davy. He resigned his post in 1840, on the death of his wife. A volume of his biography has been privately printed by his family since his decease in 1852. Dr. Leach, who entered the Museum in 1813 and retired in 1822 on account of ill health, which continued till his decease in 1826, was a naturalist of great eminence, unsurpassed in zeal for science and acuteness of intellect, but remarkable also for eccentricity of character. His labours at the Museum were of great importance in improving its classification. His successor, Dr. George Henry Noehden, a German, assistant librarian from 1822 to 1826, was the author of a much esteemed German grammar, and corresponded with Goethe. The Rev. Henry Francis Cary, assistant librarian of the Printed Books from 1826 to 1837, is universally known as the translator of Dante. His biography was published by his son in two volumes, and contains some matter of interest with regard to the Museum, especially on the circumstances which led to the resignation of Mr. Cary,—circumstances which are fully and satisfactorily explained in Mr. Panizzi's evidence before the Royal Commission in 1848. The life of Mr. Cary's successor, the Rev. Richard Garnett, assistant librarian from 1838 to 1850, has also been written by his son, but in a briefer form, and is prefixed to a collection of the Philological Essays of Mr. Garnett, chiefly consisting of papers from the Transactions of the Philological Society, and articles inserted in the Edinburgh and Quarterly Reviews. Dr. Frederick Henry Trithen, by birth a Swiss, but removed when a child to Russia, and generally considered as a Russian, was an assistant in the Printed Book department in 1844, and resigned in 1845. In 1848 he was elected the first professor of modern languages at the University of Oxford on the Taylor foundation. Mr. Edward Edwards was an assistant in the same department from 1839 to 1850. He is the author, among other works, of the article on Libraries in the eighth edition of the 'Encyclopædia Britannica,' and of 'Memoirs of Libraries, including a Handbook of Library Economy,' published in two volumes in 1859, in which is contained the longest and most elaborate history of the Museum library that has yet appeared extending to 120 octavo pages. The reader of this history would however hardly suppose that the writer was more

intimately acquainted with the Museum library than with the Bodleian, his account of both wearing the appearance of being entirely derived from books. M. Louis Augustin Prevost was also assistant in the same department from 1843 to his death in 1858, employed in cataloguing the Chinese collection. His fondness for languages was remarkable, and he had studied more or less minutely upwards of forty, with several of which he was well acquainted. Mr. Thomas Oliphant, secretary of the Madrigal Society, and author of the 'Musa Madrigalesca,' catalogued the music both in the Printed Book and the manuscript departments from 1841 to 1850. In the latter year he resigned, and may now be considered the poet of the Court for which he writes verses on festal occasions. Dr. Rosen, an eminent Sanscrit, Arabic, and Syriac scholar, editor of the 'Radices Sanscritæ,' and many other works of importance, was an assistant in the Manuscript department for some years previous to his death in 1837, and was at the same time professor of oriental languages at the London University. The Rev. William Cureton passed in 1837 from the assistant librarianship of the Bodleian to the assistant librarianship of the Manuscript department at the Museum. Mr. Cureton had given his chief attention to Arabic, and published various works in that language. The acquisition of the Syrian manuscripts during his librarianship gave him an opportunity such as might not have occurred for ages of turning to the advantage of learning his knowledge of Syriac. He resigned in 1850 on receiving preferment in the Church, and in 1859, as has been already mentioned, was appointed by the Queen the Queen's trustee at the Museum. Mr. John Holmes, his successor in the assistant librarianship (1850-54), had been an assistant from 1830, and had given evidence on catalogues before the Committee of the House of Commons in 1836. He was more inclined to contribute to the works of others than to publish anything of his own, and paid the inevitable penalty of the non-acquirement of reputation, which was within his reach. One of his contributions to the 'Quarterly Review' was an article on catalogues of libraries. The Rev. Henry Octavius Coxe, formerly assistant in the Manuscript department (1833), and now assistant librarian at the Bodleian, has been able since his removal to Oxford to publish several valuable catalogues of manuscripts in that university. There were at the same time in the Museum two officers of the name of Doubleday,—one of whom, Mr. John, was an American, and the other, Mr. Edward Doubleday, had travelled extensively in America,—but who were no relations. Mr. Edward Doubleday, an assistant in the natural history department (1842-49) was author of a magnificent work on the 'Genera of Diurnal Lepidoptera.' Mr. John Doubleday, long an assistant in the antiquities department, had an opportunity of signalising the ingenuity for which he was noted by the completely successful restoration of the Portland vase, when it was shivered to atoms in 1845. Mr. Charles Newton, an assistant in the antiquities from 1840 to 1852, afterwards consul at Mytilene, and now (1859) consul at Rome, formed the design of prosecuting his researches in antiquity on the spot in Greece and Asia Minor, and with that view applied to government for a consulship in the Levant, which was given to him by Lord Granville. His excavation of the mausoleum at Halicarnassus, and others which he has made and is making, are materially augmenting the treasures of the institution to which he belonged. Mr. Thomas Burgon, also an assistant of the antiquities department (1844-58), entered the Museum late in life, and had already passed many years in commercial pursuits in Asia Minor, where he acquired that knowledge of Greek coins which was his distinguishing characteristic.

Such are some of the past officers of the Museum, taking the word "officers" in its ordinary sense, not in the technical one in use in the official documents of the Museum, in which it is assigned to no one beneath the rank of an assistant-keeper. Of the present officers, only those will be mentioned whose names are affixed to some separate printed publication.

The keeper of the Printed Book department, Mr. John Winter Jones, has had the good fortune to discover among the treasures now under his charge, two volumes unknown to any previous bibliographer, which in the 'Archæologia' for 1846, he has demonstrated to be in the type of Caxton. Mr. Thomas Watts, the assistant-keeper, has shown, on the other hand, that a newspaper in the Museum which was supposed to be the first of all newspapers, 'The English Mercurie,' of 1588, is an entire fabrication. Both Mr. Jones and Mr. Watts have written on numerous other occasions, and in these papers they have produced information which all succeeding writers on the subject are bound to notice. The Rev. Thomas Hartwell Horne, who has been connected with the Museum library in some degree from the period when he framed the classed index to the catalogue of the Harleian manuscripts in 1808, and who in 1824 was appointed to carry out the plan of a classed catalogue, which was subsequently arrested, is universally known in America as well as Europe for his 'Introduction to the Bible,' which has been a text-book for students since its first publication in 1818. In the opinion, however, of many, even this work is surpassed in neatness of execution by his 'Introduction to Bibliography,' which has not met with the distinguished success it deserved. A complete list of Mr. Horne's numerous publications is to be found in Allibone's 'Dictionary of English and American Authors.' Mr. William Brenchley Rye has edited a volume for the Hakluyt Society on early travels in Florida; and to Mr. George Bullen we are

indebted for an elaborate 'Catalogue of the Books in possession of the British and Foreign Bible Society,' executed on a plan similar to that of the Museum catalogue. As secretary of the Hakluyt Society, Mr. Richard Henry Major, who catalogues and arranges all the maps of the Museum, had for many years the chief task of managing the affairs of that society, and was himself the editor and translator of many volumes, in particular of Columbus's Letters, and Herberstein's Russia. Mr. Joseph Zedner, to whom the cataloguing of the Hebrew books is entrusted, has in his "Auswahl historischer Stücke," a collection of extracts from Hebrew historians of all ages from the Talmud to Mendelssohn, not only shown his intimate acquaintance with Hebrew literature, but shown also that this is but a part of his acquirements. The poem of 'The Angel in the House,' has placed Mr. Coventry Patmore in a high rank among our living poets, and is still more warmly appreciated in America than in England. Mr. Richard Garnett has given earnest of high talents in a volume of poems, and has edited the 'Philological Essays' of his father. The Rev. Joseph Benjamin Maccaul and Mr. Collyer Knight have issued some publications of a theological cast.

Sir Frederick Madden, keeper of the manuscript department, is one of the best known antiquarian authors of England, editor, in conjunction with his predecessor in office, the Rev. Josiah Forshall, of the edition of Wickliffe's Bible, to prepare which fifty-five copies were collated; and editor also of the romances of 'Sir Gawayne,' and 'Havelok the Dane,' of 'Layamon's Brut,' &c. The assistant-librarian, Mr. Edward Augustus Bond, is author of some articles in the 'Archæologia,' and is now editing for the government the Trial of Warren Hastings. Mr. Charles Rieu has published some Latin dissertations on Arabic Poets, has edited Sanscrit works, and is professor of Oriental languages at University College. Mr. Edward Levien and Mr. Stephen Armytage Hamilton have published works on history. Mr. Richard Sims is author of a 'Handbook to the Library of the British Museum,' more complete for the manuscript department than for that of printed books, of an 'Index to the Pedigrees and Arms contained in the Heralds' Visitations at the British Museum,' and of a 'Manual for Genealogists,' containing useful indications of where to search for any particular fact of a genealogical nature required.

Mr. Edward Hawkins, keeper of the antiquities, has published a work on the Silver Coins of England. The assistant-keeper, Mr. Samuel Birch, is an eminent Egyptian scholar, author of several works on Egyptian Antiquities, and of an elaborate 'History of Ancient Pottery' in two octavo volumes. To Mr. William Sandys Wright Vaux we are indebted for a 'Handbook to the Antiquities of the British Museum,' and for an account of 'Nineveh and Persepolis,' which has run through four editions, and been translated into German. Mr. Augustus Woolaston Franks, who holds the office of director of the Antiquarian Society, is a contributor to the great work on the Manchester Exhibition,—'The Art Treasures of the United Kingdom;' and Mr. Reginald Stuart Poole is the author of 'Horæ Ægyptiacæ,' and of the article *Egypt* in the eighth edition of the 'Encyclopædia Britannica.'

Mr. William Hookham Carpenter, keeper of the prints and drawings, is author of a volume of 'Pictorial Notices,' chiefly consisting of a life of Sir Anthony Vandyck.

In the departments of Natural History, the name of the superintendent, Professor Richard Owen, is more universally known and respected than any other name in his branch of science, since that of Cuvier. Dr. John Edward Gray, the keeper of zoology, has made numerous contributions to zoological science, of which no less than 425 are enumerated in Agassiz and Strickland's 'Bibliography of Zoology,' published in 1852, which takes notice of papers in periodicals as well as separate publications. Dr. Gray is president of the Botanical Society. His brother, Mr. George Robert Gray, is the author of several works on ornithology, and, in particular, the standard work, the 'Genera of Birds,' in three folio volumes. Mr. Adam White has written popular histories of mammalia, birds, British Crustacea, &c., in addition to numerous scientific papers. Dr. William Baird is author of a 'History of British Entomostraca,' and a 'Cyclopædia of the Natural Sciences.' Mr. George Robert Waterhouse, keeper of the geological department, has issued the first two volumes of a 'Natural History of Mammalia.' Mr. Samuel P. Woodward is author of an excellent 'Handbook of Mollusca.' Finally, Mr. John Joseph Bennett, keeper of the Botanical department, is associated with Dr. Horsfield in the publication of the 'Plantæ Javanicæ rariores.'

Some of the most important labours, however, of the officers of the Museum are comprised in the catalogues and descriptions of the collections entrusted to their charge, which have from time to time been issued by the Institution, and which are of various dimensions and cost, from a penny pamphlet to a folio of four guineas and a half. An account of these will be given at the close of our view of the Museum, when we have gone over the separate departments, which, for the sake of convenience, may be arranged in the following order: the Printed Books, the Manuscripts, the Antiquities, the Prints and Drawings, the Departments of Natural History.

The Printed Book Department.—At the time that the Museum was first opened, in 1759, the library of printed books had already received a donation which emphatically marked it as the national library of England. In 1757 King George II., by an instrument under the great seal, presented to it the royal library, which had been accumulated by the sovereigns of England, from the time of Henry VII. downwards. The collection was indeed not large, being estimated at about 10,500 volumes; but it was rich in interest, from its numerous memorials of the Tudors and the Stuarts. The volumes brought together by Henry VII. himself comprised a remarkable series of illuminated books on vellum, from the press of the French printer, Anthony Verard. One of them, a French Boethius, is remarkable for bearing a dedication addressed to the king of England, while in another copy in the library the dedication is to the king of France, and on examination it is found that, in the king of England's copy, the word "Engleterre" has been inserted with a pen. In the reign of Henry VIII. more genuine presentation copies abounded; of one book, a translation of Galen, 'De Ratione Medendi,' there are two copies, both presented by the author, Dr. Linacre, the first president of the College of Physicians, one to Cardinal Wolsey, and the other to the king. A splendid vellum copy of the Bible of 1540 is interesting as containing in the title-page, said to be from a design by Holbein, a figure of Henry giving the Bible to his subjects, on which his own eyes must probably often have rested. It now stands in the Museum in the same press with a New Testament that belonged to Anne Boleyn. There is also King Henry's copy of his 'Assertion of the Sacraments,' the book which procured him the title of Defender of the Faith. Interesting memorials of the three sovereigns who were children of Henry, are to be found in the Greek grammar of Edward VI., in Queen Mary's copy of Bandello's novels, the book which supplied so many plots to Shakspeare, and in the volume of the 'Lives of the Archbishops of Canterbury,' the first book privately printed in England, presented to Queen Elizabeth by its author, Archbishop Parker. Another volume, which must once have belonged to the royal collection, but came to the Museum through the bequest of Mr. Cracherode, is Queen Elizabeth's copy of the first book printed in Anglo-Saxon, the edition of the Gospels superintended by Fox the martyrologist, who, a memorandum in the title-page assures us, personally presented it to the Queen. There are numerous memorials of King James I. in books offered to him by the universities, the synod of Dort, &c.; and of his unfortunate successor there are the volumes of almanacs in which he scribbled his name when Prince Charles, and the beautifully bound volumes of the Protestant nuns of Huntingdonshire, the illustrated 'Harmony of the Evangelists,' probably one of the first books so illustrated, which was brought to him by Nicholas Ferrar in 1635, and of the king's delighted reception of which there is a minute account in the life of Ferrar. Among the books which belonged to Charles II., it would be startling, were it not known that the laws of copyright began in his time, to find a copy of the second edition of the 'Pilgrim's Progress,' a book of which, strange to say, there was no copy of any edition at all in the library of George III. The Royal collection comprised the entire libraries of some eminent individuals, which had been added to it at different times by donation or purchase;—of Archbishop Cranmer; of Henry, Prince of Wales, the elder brother of Charles I.; and of the great scholar Isaac Casaubon. There is an interesting account in the lives of eminent men by Thomas Smith, of the successful efforts of Patrick Young, King James I.'s librarian to keep Casaubon's collection in England. The royal library had several eminent librarians—Leland, in Henry VIII.'s time; Roger Ascham, in Edward VI.'s; Bulstrode Whitelocke, in the Commonwealth's; and in William III.'s, Dr. Bentley.

This collection, when added to that of Sir Hans Sloane, which was generally estimated at about 50,000 printed volumes, formed a library both of extent and value. It was soon augmented, in 1763, by a donation from George III., of a very remarkable character. In 1641, at the very outbreak of the Civil War, George Thomason, a bookseller of eminence in St. Paul's Churchyard, observing the turn which public affairs were taking, and the extraordinary activity of the press, conceived the idea of collecting all the pamphlets and publications on either side, from folios to broad-sides, as they made their appearance. Never was an idea of the kind more fortunately timed, and never more perseveringly and thoroughly acted upon. For the twenty years following, though we are told it was a heavy burden to himself and his servants, and though at one time it was thought advisable to effect a colourable sale of the collection to the University of Oxford to save it from the Commonwealth, the design appears to have been never relinquished for a day. On one occasion, the King himself sent to borrow a pamphlet, and chancing to drop it in the dirt, sent a courteous apology to Thomason, who made a memorandum of the circumstance in the volume (one with the press-mark C 21 b, which contains Shawe's 'Broken Heart') on which the dirt remains to this day to attest the fact. The whole collection at last amounted to about 30,000 pamphlets, bound up in chronological order, in 2220 volumes. Ill, indeed, was the collector requited. In a statement bound up with his catalogue, and written apparently by his son, we are told that in his life-time, which lasted till 1666, he refused 4000*l.* for the collection, supposing that sum not sufficient to reimburse him. His heirs offered it to King Charles II. for purchase, and he appears to have directed the royal stationer Mearne to buy it on his account, it is not known for what sum, and afterwards to have granted as a favour permission to resell it, which the heirs of the Mearne family did not succeed in doing till they disposed of it in 1762 to King George

III., for 300*l*. The collection when presented to the Museum was known there by the name of the "King's Pamphlets," the name and merits of the collector who had displayed such sagacity, energy, and perseverance, having sunk into total oblivion.

The presentation of the Royal Library to the Museum by George II. had left his successor without a collection of books, and George III. felt the deficiency keenly. He purchased in 1762, for about 10,000*l*. a library of noted merit which had been collected by Mr. Smith, the English consul at Venice; and it is said that on an average about 2000*l*. a year were expended during his long reign of sixty years in the augmentation of his library, under the care of his illegitimate half-brother, Sir Frederick Augusta Barnard. The King himself took a lively interest in the collection, was well acquainted with its contents and arrangement, and amongst other signs of interest he showed in it was anxious to have a printed catalogue, which Sir Frederick Barnard, who lived till 1827, survived to make. No ordinary taste and judgment were shown in the selection of the volumes, in which modern history and polite literature formed the principal features; and not only was Germany well represented in both, a very unusual circumstance in an English library of the time, but the other northern countries were not overlooked, though the collections appear to have been principally made in a mass, a large number of Scandinavian books for instance being purchased at once of Thorkelin. The library was kept in a series of rooms at Buckingham House, the site which had once been proposed for the British Museum; and a view of some of the rooms which contained it will be found in Pyne's 'Royal Residences.' Some alterations which George IV. proposed to make in the building, are said to have suggested to him the idea of disposing of the library. The history of its donation is involved in some mystery. After all that has been said upon the subject by Mr. Ford in the 'Quarterly Review' (1850, v. 88, p. 143), and by Mr. Croker in 'Notes and Queries' (v. 4, pp. 155, 446), those will not err who believe that at all events enough was said of transferring it to Russia to occasion a rather energetic remonstrance on the part of Lord Sidmouth, at the instigation of Richard Heber. On January 15th, 1823, George IV. addressed a letter to Lord Liverpool, in these words: "The King, my late revered and excellent father, having formed during a long series of years a most valuable and extensive library, consisting of about 120,000 volumes, I have resolved to present this collection to the British nation." The number here stated is worthy of remark from the excellent illustration it affords of the way in which the extent of libraries is usually exaggerated. The select committee of the House of Commons had the books counted, and said in consequence, in their report, "The number of books in the library is about 65,250, exclusive of a very numerous assortment of pamphlets, principally contained in 868 cases, and requiring about 140 more cases to contain the whole." These pamphlets have been since bound in separate volumes, and now therefore the number of volumes in the library is much above that stated in the report of the committee. Notwithstanding all this discussion, in Timperley's 'Encyclopædia of Literary and Typographical Anecdote,' the edition of 1842, this very King's Library is described (at page 686) as "amounting to full 250,000 volumes in number."

In order to connect together the series of royal donations, we have stepped a little out of the order of chronological arrangement. Previous to the accession of the King's Library there had been two bequests of great importance, and each of them by trustees; the first, of the library as well as the other collections of the Rev. Clayton Mordaunt Cracherode, in 1799; and the other of those of Sir Joseph Banks, in 1820. Mr. Cracherode's collection amounted to about 4500 volumes in number, and was remarkable for the beauty, selectness, and fine condition of the books which composed it; Sir Joseph's amounted to about 16,000 volumes, and was a working library, consisting almost entirely of books on natural history and of voyages and travels, the principal extrinsic value of which consisted in the fact that in a large number of cases they were presentation copies from the authors. A minute analytical catalogue of the natural history portion of the library, which was published by the librarian Dr. Dryander, a Swede, in 1799—1805, has always been regarded as one of the best bibliographical works on natural history. Sir Joseph had previously presented to the Museum two or three collections of Icelandic works obtained during his visit to Iceland, and one of which comprised the collection of Halfdan Einarsson, author of the literary history of Iceland. By his will he left the library in the first instance to his librarian, Mr. Robert Brown, and only after his death to the Museum. As Mr. Brown survived to the year 1858, the effect of this disposition would have been not only to deprive the Museum of the benefit of the bequest for nearly forty years, but during that time to prevent the national library from even purchasing a copy of any of the books which composed the Banksian, under penalty of procuring a prospective duplicate. Fortunately an arrangement was entered into by which the Museum acquired in the person of Mr. Brown one of its most distinguished officers, as the keeper of the Banksian collection, and the library was in 1827, transferred to the national establishment. Both the Cracherode and Banksian collections are still kept entirely distinct in apartments which, although they contain other portions of the library in addition, are known by the name of the Cracherode and Banksian rooms.

Of smaller acquisitions there were many of value. Dr. Thomas

Birch, one of the most active of the early trustees, bequeathed in 1766, his library, which abounded in historical and biographical matter. Sir William Musgrave, another trustee, made, in 1799, a bequest of all such of his books as were not previously in the British Museum—a most valuable form of bequest which was afterwards imitated by Mr. Tyrwhitt, and which if it were followed out by other collectors would be of the greatest possible benefit to the national library and the least injury to the heirs. Sir William had previously presented in 1790, a large collection of pamphlets on English biography, his favourite pursuit, as is shown by his manuscript catalogue, also in the Museum, in many folio volumes, of the names of persons deceased, with indications of where notices of them had been published, a valuable book of reference to biographical compilers. The collections of the two rival historians of music, Sir John Hawkins and Dr. Burney, were finally united at the Museum, that of Sir John coming in 1778, by donation, that of Dr. Burney in 1815 by purchase. The bequest of Mr. Tyrwhitt, the editor of Chaucer, in 1786, added a fine collection of about 900 volumes of classical, and also of Italian and Spanish authors, including about 300 of the plays of Lope de Vega. The fine collection of old English plays which had belonged to Garrick was acquired in 1780, by purchase, from the widow of the great actor. A library of law books, including many rarities, was bought in 1813, of Francis Hargrave, an eminent barrister. In 1807, when Cumberland, the author of the West Indian, had sold to a bookseller about eighty volumes of the classics which had belonged to his relation, the great Dr. Bentley, and were enriched with the Doctor's manuscript notes, the circumstance fortunately became known to the librarians of the Museum in time to enable them to acquire these volumes for the national collection for the sum of 400*l*.

About this period several entire libraries were purchased. In 1815, a deputation of two of the officers of the Museum, the Rev. H. H. Baber and Mr. König, was sent to Munich to examine the library of 20,000 volumes, chiefly of natural history and medicine, belonging to Baron Moll, which was purchased at their recommendation. In 1818 nearly five thousand volumes of miscellaneous Italian and French were bought at once of the heirs of M. Ginguené the historian of Italian literature. In the same year another whole collection was obtained, and in this case an English one, the library of Dr. Charles Burney of Greenwich, the classical scholar, and son of the Dr. Burney whose musical collection had been acquired three years before. It had three distinguishing features—a collection of interleaved copies of the Greek classics with manuscript notes, another of materials for the history of the stage, consisting of printed playbills and manuscript memoranda; and another of about 700 volumes of newspapers from the earliest period to the passing day. The great prize was considered to lie in the interleaved classics, some of which are of value, and others were afterwards found to be chiefly interleaved with blank paper, or paper presenting only various readings copied from different editions in the handwriting of the doctor's pupils. The materials for the history of the stage have chiefly been turned to account by the plodding industry of one man, the Rev. John Genest, who worked at them for years, and whose anonymous 'History of the English Stage,' in 10 volumes, is chiefly filled with the dates and "casts" which they supply. The collection of newspapers, which was valued at a thousand pounds of the 9000 guineas which the printed books of the Burney collection cost, was looked on with little favour, and in the application to the House of Commons for the grant, it was considered advisable to veil this part of the collection in some ambiguity. Since Naudé had pointed out the usefulness of preserving pamphlets, that kind of acquisition had been in favour with many collectors, and it was the great boast of the Harleian library of printed books that it contained 400,000, but no one had yet pointed out the utility of preserving newspapers. The Museum was already in possession, from the bequest of Dr. Birch in 1766, of a publication called 'The English Mercury,' bearing the date of 1588, and which since 1796, when George Chalmers first called attention to it, had been looked upon not only as the first English newspaper, but the first in the world—an honour which it was destined to lose in 1839, when Mr. Thomas Watts, in his 'Letter to Antonio Panizzi, on the reputed earliest newspaper,' proved beyond dispute that it was a fabrication, which was subsequently shown to have originated, probably in a frolic, with one of the sons of Lord Hardwicke, the Chancellor, and with Dr. Birch, who was the friend of the family. The newspapers of Dr. Burney's collection comprised many of the earliest genuine specimens extant, and to some minds few of the objects in the British Museum are more interesting than the contemporary newspapers which describe the trial and execution of Charles I. Long neglected and almost unnoticed in Knight Hunt's history of English newspapers, called 'The Fourth Estate,' the newspapers of the Burney collection, have lately been partly brought to light in Andrews's 'History of British Journalism,' but still contain much that is curious, and yet awaits a chronicler. Those, for instance, who suppose that leading articles are a comparatively recent invention, may be surprised to find in the newspapers of 1649, leading articles written in a Miltonic vein, and advocating the execution of the king. The collection is indeed imperfect; the early numbers of the 'Morning Chronicle' are not to be found either in the Museum, or so far as is known elsewhere, and when Sara Coleridge was anxious to reprint her father's essays on contemporary politics from the columns of the 'Morning Post,' she consulted the Museum in vain.

The acquisition of the Burney collection, led however to an arrangement which will save future inquirers from similar disappointments. From 1818, the Stamp Office was directed to supply to the Museum its copies of London newspapers after the lapse of two years, a lapse which had previously converted them into a "perquisite," and consigned them to destruction. The English country newspapers were afterwards added, from about 1820; the Scotch from 1844; the Irish still later, but with the set beginning in 1823; and there are signs that the colonial will follow, while numerous sets of continental and American newspapers have been added at different times, and others are adding. On the ground floor in the new library, which surrounds the reading-room, large shelves of newspapers occupy two sides of a circular passage about 600 feet in length, and the space required is rapidly extending. 'The Times' alone, is now obliged to be bound in twelve folio volumes *per annum*.

Of smaller collections, it should be mentioned that Sir Richard Colt Hoare made in 1825 a most valuable present of books on the topography of Italy, which he had acquired in that country during a visit at the close of the 18th century. Four distinct assemblages of tracts on the French revolution were acquired by purchase, said to amount to about 50,000 articles, and forming collectively a sort of pendant to the Thomason collection. They form the groundwork of Louis Blanc's new 'History of the Revolution.' The Burney library was the last of importance that was acquired in a mass, by purchase; but in 1846, the most valuable addition that had ever been made to the library at once, with the exception of the "Georgian" library, was made by the bequest of the Right Hon. Thomas Grenville. Mr. Grenville, who had signed the treaty of American independence in 1783, died in the full possession of his faculties at the age of nearly ninety-one, in 1846. In a codicil to his will, dated in October 1845, he expresses himself thus: "A great part of my library has been purchased from the profits of a sinecure office given me by the public, and I feel it to be a debt and a duty that I should acknowledge this obligation by giving that library, so acquired, to the British Museum for the use of the public." The collection comprised 20,240 volumes, and had cost more than 54,000*l*., it was in admirable condition in all respects, abounding in fine bindings, in copies on vellum, and on large paper, and was altogether such a library as Dibdin delighted to describe. It was rich in choice Italian and Spanish literature, and in early voyages and travels, and in many respects dovetailed admirably with the Museum collections: the Museum, for instance, having few early editions of the 'Orlando Furioso,' or of 'Don Quixote'—the Grenville being remarkably complete in both. This, however, was the less remarkable as the intention of the donor had been confided some time before his death to his friend Mr. Panizzi, the keeper of the printed books. This fine library is kept entirely apart in a room, which contains a bust of its donor, and it has a separate printed catalogue.

Long before the fortunate acquisition of the Grenville collection, a great change had taken place in the management of the national library. Before the committee of the House of Commons on the Museum, in June 1836, Mr. Panizzi, then the second assistant librarian in the printed book department, had excited much surprise by what was considered the daring nature of his proposals. The Rev. H. H. Baber, then keeper of the printed books, had incidentally mentioned in his evidence a few days before, that the library committee of the trustees had given up holding meetings, because at one time the funds appropriated to the augmentation of the library had sunk so low as 200*l*. a-year. The sum expended on the collection of printed books had risen in 1836 to about 2000*l*. a-year, but this did not satisfy Mr. Panizzi. Lord Stanley, now (1859) Earl of Derby, who was one of the members of the committee, said to him, in a tone of sarcasm, "In short, for the accomplishment of your views you would desire first an annual grant to the amount of more than 12,000*l*. a-year for the library; next the institution of two or more libraries for the use of the public, with somewhat different views, in London; and thirdly, the removal from the British Museum of the natural history department for the purpose of affording extra space for the increased library." "Not only space," replied Mr. Panizzi ('Report of Evidence,' p. 392), "but the extra assistance which is requisite. The public have a right to expect something worthy of the nation, and I trust that this committee will see the absolute necessity of recommending something like what I have had the honour to suggest, and not less." This dialogue contains a remarkable foreshadowing of the future tendencies of the Museum, and others hardly less remarkable are to found in the series of letters already cited, which appeared in the 'Mechanics Magazine' about the same time, from the pen of Mr. Thomas Watts. Mr. Watts strongly advocated the filling up of numerous gaps in foreign literature, which he pointed out. "It is not too much to say," he observes in an article in the Magazine for 1836 (vol. xxv. p. 77), "that there must be at least 100,000 volumes on the shelves of booksellers in Europe, which deserve a place in the Museum, and might, were money liberally granted and proper spirit exerted, at once be transferred there. The British Museum should regularly take in, at least *one literary journal from every country in Europe*, containing reviews and announcements of new publications. It should be part of the duty of the librarian to peruse these, and to make a note of every work that seemed worthy of admission to the library, these might

then at once be ordered from the places of publication. . . . A constant supply of foreign literature would then be pouring in." In 1837, Mr. Panizzi became keeper of the printed book department, and on January 1838, Mr. Watts became one of his assistants. Mr. Watts had the satisfaction not only of finding his plans for the augmentation of the library approved, but of seeing himself gradually empowered to carry them out in person. Lists of all the current publications, not only in French and German, but in Spanish and Portuguese, Swedish and Danish, Dutch, Russian, Polish, Hungarian, &c., were and are procured as abundantly as practicable, and inspected by him for the purpose of marking the books to be purchased for the Museum.

The result was satisfactory. In 1843 Mr. Panizzi commenced a minute examination into the general deficiencies of the library, assisted by Mr. Jones and Mr. Watts, and in 1845 laid an elaborate report on the subject before the trustees. Unusual stress is laid in this report, on the literature of the modern foreign languages. "To be acquainted," it is said, in one passage (page 25), with the national history, laws, literature, and scientific knowledge of the Dutch or Hungarians, of the Swedes or the Danes, cannot be an object of less importance and practical utility, than to be familiar with the history, laws, &c., of the Egyptians, the Phœnicians, or the Etruscans." The deficiencies in French, Italian, Spanish, and German literature were strongly pointed out, and also those in English. "The Museum," it was remarked, "does not possess the laws, ordinances, or government acts of one-half of the dependencies of England." "With respect to English literature, or indeed any branch of English knowledge or science, the British Museum ought to afford every assistance, and the want of any English book in such an institution ought to be a rare occurrence." To improve the state of the library, Mr. Panizzi proposed a largely increased annual parliamentary grant; the trustees applied for that purpose to the Treasury, and the Lords of the Treasury recommended to Parliament "an annual grant of 10,000*l*. for some years to come, for the purchase of books of all descriptions." The effects of this liberality were of course soon visible. The number of volumes added to the library of printed books in 1845 was 12,163; in 1846 it rose to 31,848; and in 1847, aided by the 20,000 volumes of the Grenville library, it was no less than 55,475. In 1848 it was 22,056 but in 1849 it sunk to 14,266, and in 1851 was only 11,492, or little more than a third of what it had been five years before. The vast increase of volumes led of course to increased requirements for binding and cataloguing, and, above all, for space. As it was considered useless to purchase what room could not be found for, and thus lead to complaints that books in the Museum were not accessible, the grant was reduced to 4500*l*., and even less; and it was only after the erection of the new library, which was completed in 1857, that the large scale of grants and purchases was resumed. In the estimates for 1858, and in those for 1859, the sum of 10,000*l*. is again set down for printed books.

The magnitude of the effects of the impulse given in 1845 is best shown by a statement of the number of the volumes in the library, before and after. "The library," says Mr. Jones, the present keeper, in his 'Guide to the Printed Books,' dated February, 1858, "has been twice counted; the first time on the 25th of July, 1838, when the number of printed volumes was found to be 235,000, and again on the 15th of December, 1849, at which period they had increased to 435,000. They are now about 550,000, and the annual increase is not less than 20,000 volumes." The total number of volumes added in 1858 was 32,152. It may be added, that in the year 1821, before the accession of the King's Library, the number of the national collection was stated at less than 116,000; and that probably, at that period, the belief was more prevalent than it has ever been since among the public in general, that "the library of the British Museum contained a copy of every book ever printed." There is perhaps no better symptom for the prospects of the library, than that this belief has become less confident in the exact proportion that it has become less absurd, and that at present the librarians of the Museum are the first to acknowledge, that whatever the comparative merit of the collection, it is still far from being what it ought to be in point of attainable completeness. In every branch of learning in which a student commences to prosecute real research at the Museum, he will soon discover, even now, that considerable gaps exist.

The state of the library is, nevertheless, very different from what it was twenty years ago, and it now stands perhaps second in the list of the great collections of Europe. The libraries of France and Italy and the South have in general founded their claims to admiration on such merits as Dr. Dibdin gives most importance to—the rarity and beauty of particular volumes contained in them, their general good condition, and their extent. In the libraries of Germany, Scandinavia, and the North in general, on the other hand, more attention has been paid to scientific completeness, and to excellence of cataloguing and arrangements. Copies on vellum or on large paper, or in remarkable bindings, sets of Alduses or Elzevirs, have been amassed in the one; complete sets of books on a particular subject, well classed, in the other. In the Museum there is a combination of both these claims. The King's library, both old and new, the Grenville, and the Cracherode collections, would alone suffice to place it on a high level in point of rarities and curiosities, and there has been no falling-off in purchases of this kind during the administration of Mr. Panizzi and his successor, Mr. Winter Jones. The Roxburghe ballads, early editions of the Bible, early Service

books, early editions of Shakspere's plays,—everything that is rare and curious has been secured whenever an opportunity occurred. In the early part of the 19th century, when bibliomania was so prevalent, the name of the British Museum was scarcely heard in a sale-room; of late years its agents have been incessantly active. While thus increasing in splendour, the library has been equally increasing in usefulness. For the first time in the history of literature, an attempt has been made on a large scale to bring under one roof all the current literature of the world that had any intrinsic value, regardless of the language in which it might be couched. Mr. Watts, in his proposals, spoke of "one journal from every country in Europe;" and at the time he wrote there was no journal in the Museum in the Russian language: the catalogue now contains eighteen. The Museum is now supposed to possess the best Russian library in existence out of Russia; the best Hungarian out of Hungary; the best Dutch out of Holland;—in short, the best library in every European language out of the territory in which that language is vernacular. The books are in every case the standard books of the language,—the laws, the histories, the biographies, the works on topography and local history, the poets and novelists in most esteem;—in short, all that moulds or paints the life and manners of a nation, and which now a student of any European language need travel no farther than to the reading-room of the Museum to see and make use of.

The literature of the English language in the United States was another point that engaged attention, and orders were sent out as early as 1839 to America direct. At present the number of American books in the Museum is greater than in any library of the United States. A separate catalogue of these books has been prepared by Mr. Henry Stevens, the American agent who has had the largest share in procuring them, and it fills two octavo volumes, printed in double columns, which have not as yet been issued to the public.

For the augmentation of the collection of English books reliance had been placed, in the earlier stages of the Museum, on its legal rights. The donation of the Royal Library to the Museum by George II., in 1757, was accompanied by that of the royal privilege of gratuitously receiving from the publishers a copy of every work printed in the English dominions. This had first been granted to the Crown by an Act of Parliament of the 14th of Charles II., and subsequently renewed after expiry by the famous Copyright Act of the 8th of Queen Anne. Dr. Bentley, when keeper of the Royal Library, complained of the constant evasion of this Act by the booksellers; and the complaints were often renewed by the librarians of the Museum, though from about the year 1818, when Mr. Baber, then keeper of the printed books, gave some curious evidence on the subject before the Copyright Committee, there was certainly a great improvement. The new Copyright Act of 1842 gave a pre-eminence to the Museum among other libraries to which the privilege was conceded, and provided that in case of non-compliance with the Act the negligent publisher might be taken before a magistrate and fined. In 1850, the superintendence of this part of the Museum business was transferred to Mr. Panizzi, as keeper of the Printed Book department, and the strictness with which he enforced the Act led to a great augmentation in the number of books received. At present all is collected that issues from the English press down to the most insignificant work on crochet, to a Child's Missionary Magazine, the directory of a country town, or a circulating library novel; and everything that is collected finds its place on the shelves and in the catalogue, in the conviction that it may often be a point of importance to preserve one copy of even a worthless work in a repository where it may instantly be referred to in case of need. A different system prevailed in former days, when it does not seem to have struck a single individual that it might probably be of advantage to preserve a set of the 'London Directory' or the 'Navy List,' and a complete collection of either is, in consequence, not to be found in the British Museum or apparently anywhere else.

The Oriental collections of the Printed Book department have not yet been mentioned. In 1759, the year of opening, a choice and valuable collection of 180 Hebrew volumes in the binding, apparently executed for King Charles II., whose marks it bears, was presented by Mr. Salomon da Costa. No considerable additions were made to the Hebrew till 1848, when Mr. Panizzi purchased a selection of 4420 volumes from a library of Hebrew, which had been formed by Mr. H. J. Michael of Hamburg, and purchased entire by Mr. Asher, the learned bookseller of Berlin, the most able and zealous of the continental purveyors for the Museum. In 1836, a collection of the works in Armenian, published by the Mechitarist monks of Venice, was purchased by Mr. Baber; to this, considerable additions were afterwards made, including, among other works, a book that would hardly have been looked for in Armenian, a translation of 'Uncle Tom's Cabin.' It may be worth while to mention that advantage has been taken of the polyglot popularity of Uncle Tom's Cabin, to afford students an opportunity, not otherwise procurable, of studying the colloquial and familiar idiom of different countries. Versions have been procured or ordered in almost every European language, and there are some, Welsh and Wallachian for instance, in which there are double or triple versions of this particular book, while there is hardly a double version of any other except the Bible. The collections of Arabic, Persian, and Turkish, at the Museum, as well as of Sanskrit and the other Indian languages, are very susceptible of improvement,

but of Chinese there is a large collection. One bequeathed in 1825, by Mr. Fowler Hull, forms the nucleus; many other volumes were afterwards selected and purchased on different occasions, and in 1847 the collection of Chinese books belonging to Mr. Morrison the younger, amounting to 11,500 volumes, was purchased by government and presented to the Museum. In Chinese literature the library may now, therefore, be considered at least on a level with any other in Europe, and no opportunity has been lost of procuring specimens of the Mongolian, the Mantchoo-Tatar, and other languages of Eastern Asia.

The maps and music are collections both of which are connected with the Printed Book department, and both of which are in a course of development unknown to them twenty years ago. The collection of maps in the King's Library is a remarkably rich one, accompanied with a large collection of topographical prints and drawings, and is arranged in more than 100 folio volumes. The music was formerly confined to that received by privilege only, in addition to the works acquired by the purchase of the library of the elder Dr. Burney, and received by the donation of Sir John Hawkins. It has now extended to more than 4000 volumes, and is still extending.

The catalogue of the British Museum has been a subject of frequent discussion in the public press, since the committee of the House of Commons in 1835. Before that time, in 1824, the Rev. Thomas Hartwell Horne had been appointed to superintend the preparation of a classed catalogue; but in 1834 his labours and those of his colleagues had been suspended, and the Rev. Mr. Baber had been directed to draw up plans for an alphabetical catalogue. A long correspondence on the subject will be found in the Appendices to the Reports of the Commons' Committee and of the Royal Commission. When, after Mr. Panizzi's appointment to the keepership, the library had been removed from the old to the new building, the question of cataloguing and of printing the catalogue again came up; and a small committee of the Printed Book Department, presided over by Mr. Panizzi, drew up in 1839 a series of rules for that purpose, which amounted, when they finally received the sanction of the trustees, who re-discussed them, to the number of ninety-one. Objection has been made to their number; but it must be remembered that it was requisite to provide beforehand for all the contingencies to be foreseen in operating on a large library by several hands; and experience shows that the variety in the notions of cataloguers is wonderful. In the King's Library catalogue, for instance, though it is professedly alphabetical, all the novels and tales by anonymous authors, from Amadis de Gaul to Waverley, are entered in a mass, under the singular heading of 'Fabulæ Romanenses.' In such a title as the 'Second Report of the Auxiliary Trinitarian Bible Society of St. James's, Clerkenwell,' there is hardly a word, except the particles, which has not been selected by some cataloguers as a heading, many taking even the word "Second;" though it is evident that, on that principle, a set of twenty of these reports would figure in twenty different parts of the same list. It is evident that difficulties of this kind do not diminish when foreign languages are to be treated, which, in the case of the Museum library, are not few in number. A commencement was made of printing the catalogue compiled on the new principles, and in 1841 the first volume, containing the letter A, appeared under the superintendence of Mr. Panizzi; but immediately afterwards the printing was suspended, and one of the objects of the royal commission of 1847 was to inquire into the cause of this suspension. The commission approved of the step which had been taken, for the reasons assigned by Mr. Panizzi, that it was eminently unadvisable to print any portion of an alphabetical catalogue before the whole was ready for the press. Since this decision has been arrived at, the revision of the old catalogue has continued in manuscript, while all the fresh books added have been dealt with on the same principles; but, as has already been stated, the number of volumes in the Museum before the year 1839 was about 235,000, while the number since added exceeds 335,000; so that the bulk of the supplements, had the catalogue been printed, would in 1859 have already exceeded that of the principal. The immense labour expended on this gigantic work would perhaps have been more highly appreciated by the public, had some of its results been embodied in print. The knowledge and care required in settling the items of an extensive catalogue might often win a reputation if exerted in some other direction, but apparently will never in England win a reputation in this.

When a new book has been catalogued, the next step to be taken with it is to place it on one of the shelves in a press or book-case, that it may receive its appropriate "press-mark," that is, the indication of its locality. At the Museum each press or book-case has a certain number, and the different shelves are indicated by the letters of the alphabet. Thus the press-mark '1340 a,' indicates that the book is placed on the 'a' or topmost shelf of press or book-case 1340. Nothing can be more simple, yet this simplicity is rare. In another library in London, for instance, the system is exactly reversed, the presses are marked with the letters of the alphabet, and the shelves with numbers; the consequence is, that as the letters of the alphabet are soon exhausted, the librarians have to commence a second series by repeating them thus, AA, BB, &c.; then a third and a fourth on some other principle, and long before they have arrived at as high a number as 1340, the system is involved in inextricable entanglement. As the shelves in any book-case never amount to the number of

the letters of the alphabet, no difficulty of the kind can occur with them. Yet the system of numbering the presses appears to have been slow in suggesting itself to librarians in general; Sir Robert Cotton named his book-cases after the Twelve Cæsars, and in order to find a book it was necessary to remember the succession of Otho, Vitellius, and Vespasian. When his book-cases outgrew the number of twelve, he abandoned even this system for a worse, and instead of proceeding in succession with the "five good Emperors," arbitrarily introduced Cleopatra and Faustina. At the Advocates Library in Scotland, the presses were patriotically named after the succession of the Scottish kings, then the additional ones after the signs of the zodiac, &c., till necessity drove them to the adoption of numbers, lest they should be compelled to make every new attendant go through a small course of the sciences before he could find a book. The great problem in the arrangement of a library, which is increasing, is so to place every book as it comes in, that it may receive a press-mark which will never have to be altered, and yet to provide that the classes of books shall be kept together; that a new book of travels in Australia, for instance, shall stand with other books of travels in Australia, and not with Spanish plays or the Acts of Parliament. A system of this kind would seem to be peculiarly difficult to establish in a library which is increasing at the rate of 20,000 volumes a year, and yet at the Museum a plan of extreme simplicity has been adopted, which is found to answer its purpose. Let us suppose that a room has been built which contains 100 book-cases, each capable of containing 150 volumes, and therefore that the room will contain 15,000 volumes in all, but that the possessor has 1000 volumes only to place in it at the outset, intending to purchase for the next fourteen years 1000 volumes a year. It is evident that if he numbers his presses from 1 to 100, and proceeds to place his several books, the very first few volumes that he marks with a press-mark hamper him in a certain degree as to the places of all the others. If he assumes that his purchases of books in English history will finally occupy a single press, and therefore places an edition of Hume in press 77, and occupies press 76 on one side of it with ancient history, and press 78 with the history of France; he may find a year after that his purchases in English history have filled press 77, and in French history press 78, and that he requires more room for both, but that the only space he has left is in press 2 among the bibles, or in press 99 which is entirely vacant, but stands next to the works of Shakspeare. The order which he has endeavoured to preserve is therefore spoiled: he must either fill up the vacant spaces with incongruous books, or shift the position of a number of them and alter the press-marks. The problem will be certain to recur over and over again before the room is filled, and each time the remedy will be more hard to effect and more wearisome. One simple change of feature in the arrangements adopted at the outset will obviate all the difficulty. We have supposed that he has marked his presses with fixed consecutive numbers from 1 to 100; let us suppose that he marks them instead with moveable numbers not consecutive, leaving gaps between, and the whole trouble is got over. Assume, for instance, that he places his Hume just in the same position but marks the press 283, and places the French history still in the next press, but marks that press 315. When, in the course of a year or two, he finds that he wants additional room for English history, and that the last press but one in the room is vacant, he removes the contents of the last press but two into the last press but one, removing the number with it, and by repeating the process obtains a vacant press immediately after his press of English history, which is exactly what is required. The new press between 283 and 315 he marks with some intermediate number. The process can be repeated as often as requisite, and the gain is obvious; the press-marks remain the same, and, though not consecutive, they stand in sequence, and serve as a ready and easy guide. The books are moveable, and yet the press-marks are permanent. The processes we have supposed are precisely those which have actually occurred at the British Museum. When, in 1838, the old library was moved from Montague House to the new apartments in the northern range, the press-mark of every book, and every tract in a book (of which there are sometimes more than a hundred in a volume), was altered. The task of arranging the library in its new position was entrusted to Mr. Watts, who in the course of that and the eighteen following years, during which every book that entered the Museum passed through his hands, must have examined and classed upwards of 400,000 volumes. The rapid augmentation of the collection, and the system of marking the presses with consecutive numbers, made it necessary that the accumulations should be arranged in three successive sets or series. The idea of the plan of *in*consecutive numbers occurred to Mr. Watts long before it could be carried into effect, as to exercise it, it required that all, or nearly all, the presses should be of similar height and size, and the presses in the new building often varied considerably. The new scheme, on receiving the sanction of Mr. Panizzi, was finally commenced in the long room by the side of the King's Library. The presses in that room amounted to about 600, but in the numbering a range of numbers was assumed from 3000 to 12,000. The numbers from the beginning of 3000 to the end of 4000 were assigned to Theology, from 5000 to 6000 to Jurisprudence, from 7000 to 8000 to Philosophy, Science, and Art, from 9000 to 10,000 to History, from 11,000 to 12,000 to Literature. A particular subdivision was assigned to each "century" of numbers; it was assumed, for instance,

that dramatic literature would occupy a hundred presses, from 11,700 to 11,799, and thus every drama which has been "placed" on the new system bears in its press-mark 117 for the first three figures of the five. This system, which is known by the name of "the elastic system," appears to promise several advantages besides those which have been already derived from it. It is evident, for instance, that if one copy of the title-slips of the books thus placed and marked were arranged in the order of the press-marks instead of that of the authors' names, it would *ipso facto* produce a rough classed catalogue; and thus a problem which has been thought insoluble would be solved in the simplest manner.

When the title-slip of a new book has received the press-mark of its locality, it is ready to be entered in the manuscript catalogue, and passes therefore into the hands of the "Transcribers." The present catalogues of the Museum are as novel as many other of its arrangements. Formerly, the titles were simply written into an interleaved copy of the printed catalogue, a copy of which was kept in the reading-room. As it could not be calculated beforehand what the insertions were to be, the same difficulty was perpetually recurring with the alphabetical order of the entries as with the classified arrangement of the books, and the only remedy in use was to cancel a sheet whenever required, and re-write the entries over a larger space. The system was not found adequate to the requirements of the Museum, when the augmentations rose to the rate of 20,000 volumes a year. The present system is that of using prepared paper and a kind of "stylus," so that four copies of each entry are produced at once. These copies, which are necessarily on thin paper, are mounted on thicker paper by the bookbinder, so as to be equal to considerable wear and tear, and are then fastened on the pages in the volumes of the catalogue, in such a way that, if required, they can be readily taken up again and removed to another page. By this means the exact alphabetical arrangement of the catalogue is continually kept up, to the great advantage of the readers who consult it. This system is found in action in the long array of volumes, now (June, 1859) about 900 in number, which occupy one of the central stands in the reading-room, and contain a consolidated list of all the collections in the Museum up to as far as the letter G in the alphabet, and beyond the letter G, the augmentations of the years since about 1850. It is also applied to the separate catalogues of the collections of maps and music, a series of which also stands in the reading-room, amounting respectively to 79 and 52 volumes. In addition to the catalogue in 900 volumes, the reader who does not find in it a work that he requires of an older date than 1849, and of which the author's name begins with one of the letters of the alphabet that come after G, should consult the 'Old Catalogue,' in 82 interleaved volumes, the catalogue of the King's Library, and the catalogue of the Grenville Library, all standing side by side in the reading-room, in the circular book-stands towards the centre.

The Grenville Room and the King's Library are now made use of for the purpose of exhibiting to the general public a selection of the most interesting curiosities of the library, a notice of which will perhaps be most appropriate here. A selection of this kind had long existed in the "show-cases" and "select cases" of the interior of the library, but was not made public till the "Great Exhibition year" of 1851, and after that period was again closed, till the book-cases of the King's Library having been glazed to protect the books from dust, that magnificent room was again opened to the public, in conjunction with the Manuscript and Grenville Rooms, at the suggestion of Mr. Panizzi. The books now shown occupy fourteen cases, the contents of which are described in a 'Guide to the Printed Books,' by Mr. Winter Jones, sold at the Museum. A series of no less than twenty-four block-books and impressions from early blocks is exhibited, forming as valuable a collection as any perhaps in the world, with the exception of that of Munich. They include four editions of the 'Biblia Pauperum,' and the edition of the 'Book of Canticles,' which is so important to inquirers into the early history of printing, from its bearing a Dutch inscription, the authenticity of which has been doubted, but will be doubted no longer by those who see this copy. We find also the broadside entitled 'Temptationes Demonis,' of which no other specimen is known; the other copy once supposed to have existed being now identified with this; and the 'Speculum humanæ Salvationis,' supposed to have been printed by Koster. The Latin Bible known as the 'Mazarine Bible,'—the earliest book that was ever printed, according to the general belief, and certainly one of the finest,—is there, in company with the Latin Psalter of 1457, printed by Faust and Scheffer, the earliest book that bears a date, and renowned for the splendour of its initial letter, printed in colours. The first book printed in Italy, and the first in France, are shown, as well as the first book printed in England, 'The Game of the Chesse,' executed by Caxton at Westminster Abbey in 1474. It is said, in Walter Scott's 'Antiquary,' that the copy there described by Oldbuck as having been acquired by "Snuffy Davy" at a stall in Holland, for the "easy equivalent of twopence sterling," is the very same copy that passed into the library of George III.; but this appears to be a mistake. The King's copy of the 'Recuyell of the Historyes of Troye,' of the date of 1471, the first book printed in the English language, was bought for the royal collection at a sale in 1773 for 32*l.* 11*s.*; while at the Roxburghe sale, in 1812, a similar copy sold for 1068*l.* 18*s.* It lies in the show-case by the side of the French book of which it is a translation, also

printed in Caxton's types, and considered to be the first book printed in French. Specimens of illuminated printing, and of illustrations on wood and copper-plate, fill some of the other cases; and one is devoted to specimens of binding. In this are shown beautiful proofs of the taste of Grolier and Maioli, and also volumes of remarkable binding that have belonged to King Henry VIII., Queen Elizabeth, and Mary, queen of Scots, and show the taste of the times. A walk through the King's Library, and an inspection of the treasures it contains, are in themselves a small course of bibliography.

A history of the reading-room of the Museum is now in course of preparation by Mr. Winter Jones, to be prefixed to a printed catalogue of the books it contains, which has been some time preparing for the press. The number of visits to the reading-room has undergone an increase similar to that to the Museum in general. The regulations for its management at the outset, in 1759, were of the same cautious and restrictive character with those for the general establishment. After some stringent rules with regard to admission, it was ordained (Regulation 3) "that a particular room be allotted to the persons so admitted, in which they may sit and read or write without interruption during the time that the Museum is kept open; that a proper officer be constantly present in the said room as long as any such person or persons shall be there; and for the greater ease and convenience of the said persons, as well as security of the collection, it is expected that notice be given in writing the day before by each person to the said officer, what book or manuscript he will be desirous of perusing the following day, which book or manuscript, on such request, will be lodged in some convenient place in the said room, and will from thence be delivered to him by the officer of the said room; excepting, however," &c. &c. Gray, the poet, was one of the first to avail himself of the opening of the room, and some mention of it, in his usual tone of splenetic humour, is to be found in two or three of his letters. "I often," he writes, in August, 1759, "pass four hours in the day in the stillness and solitude of the reading-room;" and in another letter he describes the company, which at that time consisted of only four other readers, two of whom were Prussians, while Dr. Stukeley, the antiquary, and a copyist made up the number. Foreigners and antiquaries appear to have continued to be frequent visitors, and towards the close of the century, French emigrants almost outnumbered the native English. D'Israeli the elder, in the last edition of his 'Curiosities of Literature' which he superintended, gave a few lines to his reminiscences of the quiet old room. In 1803, almost simultaneously with the death of Dr. Penneck, who had been for forty-two years keeper of the reading-room, several alterations in the arrangements were made, and the old room was changed for a new one. Peller Malcolm, in his 'Londinium Redivivum,' published at that time, gives a description of both. "The reading-room, till the winter of 1803, was," he says, "a large vaulted apartment with a clumsy marble chimney-piece, but having only two windows, which were insufficient to illuminate the most remote parts of the table." "The present reading-room," he continues, "is surrounded by shelves of books secured by wire, has a vaulted ceiling, a handsome cornice, and a large marble chimney-piece, &c. &c. Two long tables extend north and south, on each side of the fire-place, for the readers; these are covered with green cloth, and are plentifully supplied with pens, ink, and rests for the books. Catalogues are placed on shelves within the room, which the reader consults at pleasure, writes his notes from them, pulls the bell-rope near the door, a messenger instantly obeys the summons, and in as short a time as possible returns with the wished-for book." By the rules promulgated in 1803, no reader, except in particular cases, at the discretion of the principal librarian, was entitled to more than two volumes at a time, but they might be exchanged as often as he required. As the library and the metropolis both went on increasing, so did the visitors to the reading-room. "At the time when these buildings were first under consideration," said Sir Robert Smirke, in his evidence before the Committee of 1836, "it was stated to me by one of the principal officers of the Museum, that the average number of readers daily attending the rooms was 30. He stated at the same time that he thought it probable, if more convenient arrangements were made for their reception, they might be increased to 80, or even perhaps 100. There are now frequently 200, and yet more accommodation is wanted." This accommodation was provided in the new buildings, first in two temporary rooms in the south-east corner, to which access was gained by a steep flight of steps, and after 1838, by two rooms in the north-east corner, built expressly for reading rooms, but to which the entrance was by a door in the basement. There were parts of the principal room in which reading was impracticable at certain times of the day till some alterations were made, by perforating the gallery above, introducing reflectors, &c., which at last shed sufficient light on the tables below. As the number of readers increased, additional tables were introduced, which had, however, the effect of making the passages between inconveniently narrow. The ceiling of the reading-rooms being only 31 feet high, the ordinary height of the apartments on the principal floor, the atmosphere, when the attendance of readers had been numerous, became oppressive and disagreeable towards the close of the day. These considerations made the readers welcome with a pleasure mixed with surprise the news that the splendid reading-room was in progress, which was finally opened to them on May 20th, 1857. Some description of this room has already been given

in our account of the building. The number of readers instantaneously doubled, and the daily average in 1858 was 424. Many of these are ladies, for whose exclusive accommodation there are tables affording fourteen seats, while they are always at liberty to take a seat at any other table they prefer. On three or four occasions the whole of the seats in the room, which are 302 in number, have been occupied at once; and when the immense population of London, the ease of obtaining admission to read, and the value of the privilege are considered, no surprise will be felt at the circumstance. Those who obtain admission have at their command, arranged on the walls around them, a select library of 20,000 volumes, comprising books of reference of all kinds. They may at pleasure, by merely writing for what they want, obtain as many volumes as they please of a printed and manuscript library of more than 600,000 volumes, beyond all comparison the finest in England, and probably at this moment the completest for use in Europe. Their ample seats in a magnificent room are furnished with every accommodation for writing and reading, and they are met on all sides with civility and attention. Some improvements may yet be required, but such advantages as those now accessible without fee or reward, were inaccessible on any terms to a former generation; and even now, a nobleman in his private library may often miss facilities to be found in the reading-room of the Museum.

The following are the most important directions respecting it, taken from a printed paper which is delivered to every reader.

"The reading-room of the Museum is open every day, except Sundays, Ash Wednesday, Good Friday, Christmas Day, and any Fast or Thanksgiving days appointed by authority; except also from the 1st to the 7th of January, the 1st to the 7th of May, and the 1st to the 7th of September, inclusive.

"The hours are from nine till four in the months of November, December, January, and February; from nine till five in the months of September, October, March, and April; and from nine till six in the months of May, June, July, and August.

"Any person desiring to be admitted into the reading-room is to apply *in writing*,—addressed "To the Principal Librarian of the British Museum," and not otherwise,—specifying his description and place of abode, and accompanying his letter *with a written recommendation*, satisfactory to an officer of the Museum; and thereupon, the principal librarian may grant him admission for a term not exceeding six months, or refer the application to the trustees at their next meeting. Any reader, once admitted, may apply at the close of his term for the renewal of his ticket, without a fresh recommendation, but producing his last ticket of admission.

"The tickets of admission given to readers are not transferable, *and each person must, if required, produce his ticket.*

"Persons under eighteen years of age are not admissible.

"Readers, before leaving the room, are to return the books, manuscripts, or maps which they have received to an attendant, and are to obtain the corresponding ticket; *the reader being responsible for such books, manuscripts, or maps so long as the ticket remains uncancelled.*

"It may be sufficient merely to suggest, that *silence* is absolutely requisite in a place dedicated to the purposes of study."

Department of Manuscripts.—The history of the Manuscript department is in its general outline similar to that of the Printed Books, though its development has of course not been so immense. It was formed at the outset by the union of four great collections; other whole collections were afterwards added from time to time by purchase; and more recently a liberal expenditure has taken place in making selections at sales, both English and foreign. The Harleian, Sloanean, and Cottonian manuscripts formed the nucleus of the department, followed, in 1757, by the manuscripts of the ancient royal library of England. This last collection, of about 1950 volumes, contains whatever had been brought together by our kings, from King Richard II. to King George II. Many of these manuscripts came into the royal collection at the time when our monastic institutions were destroyed, and some still retain the anathemas upon their spare leaves which the donors denounced against those who should alienate the respective volumes from the places of their original deposit. Old scholastic divinity abounds in this collection; but it possesses also about fifty volumes of Chronicles, some of which appear to have been executed for King Edward IV., and a volume of romances presented by Talbot, earl of Shrewsbury (Shakspere's Talbot), to Margaret of Anjou. The great ornament of the collection, however, is the 'Codex Alexandrinus,' an ancient Greek copy of the Scriptures, supposed to have been executed by Thecla, a lady of Alexandria, in the 4th or 6th century, and presented by Cyril Lucar, the patriarch of Constantinople, to King Charles I. It is generally acknowledged by critics to be one of the two most ancient copies of the Scriptures in existence, and an elaborate edition of the New Testament portion of it was executed by Dr. Woide, and of the Old Testament portion, at the public expense, by the Rev. H. H. Baber, from 1822 to 1837 keeper of the Printed Books. It has also many volumes, enriched by the finest illuminators of different countries, in a succession of periods to the 16th century; a numerous assemblage of the domestic music-books of Henry VIII.; and the Basilicon Doron of King James I., in his own hand-writing.

The Cottonian collection originally consisted of 958 volumes, which were supposed to be reduced to 746, exclusive of some fragments, by an unfortunate fire which injured it in 1731, when it was deposited at

Ashburnham House in Westminster. Some of the injured volumes however were partially restored at the commencement of the present century; and since 1845 many have been recovered with singular skill by Mr. Gough, who has been employed for the purpose. The collection is rich in books that formerly belonged to monastic libraries, and in state papers of the most interesting description, coming down to the time of the collector, Sir Robert Cotton, who was born in 1570 and died in 1631. It abounds in Anglo-Saxon manuscripts, one of which is the invaluable 'Durham Book,'—a copy of the Gospels written between the years 698 and 720, and interlined with a translation in Northumbrian Saxon, which belonged to the cathedral of Durham, and was supposed to have been by miracle preserved from destruction by the heathen Danes. A facsimile of some of its beautiful illuminations is given in Sir Frederick Madden's 'Illuminated Ornaments reduced from MSS. and early printed Books, from the 6th to the 17th centuries,' in which Sir Frederick, the present keeper of the department, gives the history of many of the treasures under his charge. Another interesting Saxon book is a copy of the Gospels supposed to have been used to administer the oath at the coronation of the Saxon king Athelstan, and which was certainly used for that purpose at the coronation of King Charles I. More than 200 volumes of the Cottonian collection consist of the letters of kings and statesmen, and have supplied some of the most interesting matter for Sir Henry Ellis's three collections of 'Letters Illustrative of English History.' Among its treasures is one of the original copies of 'Magna Charta,' unfortunately much damaged by the fire at Ashburnham House, respecting which the story is told that Sir Robert Cotton accidentally discovered it in the hands of a tailor, who was going to cut it up for a measure.

The Harleian collection, which was purchased for 10,000*l.* only, consists of 7639 volumes, exclusive of 14,000 original rolls, charters, deeds, and other legal instruments. Its contents are as miscellaneous as they are valuable; they embrace all languages, from English and Latin to Slavonic and Chinese, including "poems, essays, ditties, ancient ballads, plays, and other poetical pieces, in almost every modern language," but particularly in French and English. There are a great number of volumes of original and transcribed letters, of service-books of the Romish Church, of Visitations of Counties and other heraldic manuscripts, and there are some valuable manuscripts of classical antiquity, —a very early 'Odyssey,' and two copies of the Latin Gospels in letters of gold.

The Sloane collection, consisting of 4100 volumes, chiefly of the 16th and 17th centuries, comprises a number of alchemical and medical manuscripts, and several on natural history, including some fine drawings of insects by Madame Merian. Its most valuable materials are volumes of voyages and travels, in particular the papers of Kämpfer, the first scientific describer of Japan, the original manuscript of whose work is among them, and the scientific correspondence of Sir Hans Sloane, and others. The Lansdowne manuscripts, 1245 volumes, bought in 1805 for 4925*l.* of the heirs of the first Marquis of Lansdowne, better known as the Earl of Shelburne in his career as a statesman, chiefly consists of materials for English history and topography, including some chronicles and letters of value. The Hargrave collection of 500 manuscripts was in 1813 bought with the rest of the possessor's library for 8000*l.* during his lifetime, and relates entirely to law, the most noticeable object being an 'Abridgment of Equity,' in 45 volumes, by a Master of the Rolls. The Burney collection of about 520 volumes, bought with the printed book library of the same owner, and valued separately at about 4500*l.*, is distinguished for its classical manuscripts, eighty of which are in Greek, and among them a fine Ptolemy's Geography of the 15th century, and a celebrated copy of the Iliad, formerly belonging to Mr. Charles Townley, of a date not later than the end of the 13th century, and which was separately valued at 600 guineas. The presentation of the library of George III. brought with it about 440 volumes of manuscript, one of them the album of King Charles I., with the autographs of all the most distinguished personages of his court; another the original manuscript of Dr. Johnson's tragedy of Irene, and another some autograph correspondence of Dr. Franklin. At the death, in 1829, of Francis Henry Egerton, the eighth Earl of Bridgewater, he bequeathed to the Museum not only a collection of 67 manuscripts, chiefly relating to French and Italian history and literature, but the sums of 5000*l.* and 7000*l.*, the interest of the former to be employed in purchasing additions to the Egerton collection, and of the latter to paying the salary of an Egerton librarian. In 1838, Lord Farnborough, a trustee, left at his decease a sum of more than 80*l.* a year as an addition to the Bridgewater bequest. There is therefore an annual augmentation of the Egerton collection at the Museum by means of manuscripts specially purchased from this united fund. In 1831 and 1835, the Museum, by agreement with the Royal Society, acquired what is called the Arundel collection of manuscripts, which had been brought together by the Earl of Arundel, afterwards Earl of Norfolk, who died in 1646. The collection was presented to the Royal Society in 1681, by Mr. Henry Howard. It consists of 600 volumes, and contains a large assemblage of books of jurisprudence, forming what was probably considered in the middle of the 15th century, a complete library of civil and canon law, but it has also abundant materials for the history of our own country and language, including among several early chronicles no less than seven copies of Geoffrey of Monmouth. Books

of early English poetry, and manuscripts illustrating the language of France in the 12th and three succeeding centuries, also add to its value. In 1841, the Museum purchased in a mass the manuscript collection of Dr. Butler, bishop of Lichfield and Coventry, consisting of biblical manuscripts, copies of classical writers, and a collection of autographs.

These are the main separate collections of manuscripts. Of the collections which may be said to have merged in the general one, some of the most important on historical and topographical subjects are Rymer's partly unused materials for his 'Fœdera,' in 58 volumes, and Madox's for his 'History of the Exchequer,' in 94; Lyson's for his 'Environs of London,' and 'Magna Britannia,' in 64; Archdeacon Coxe's for his different historical works in 206; Dr. Birch's valuable historical and biographical transcripts, in 378; Cole's collections for a history of Cambridge, of Cambridge University, and Cambridgeshire, in 92; Hasted's collections for Kent, in 62; Sir William Burrell's and the Rev. William Hayley's joint collections for a history of Sussex in 41; Wolley's for Derbyshire in 53; Jermyn's for Suffolk, in 51; Davy's for Suffolk in 160. The diplomatic correspondence of Sir Andrew Mitchell, known as the ambassador to Frederick the Great, in 69 volumes, and that of Count Joseph de la Puisaye, an active adherent of the Bourbons, during the French revolution, in 117 volumes; the papers and correspondence of the Marquis Wellesley, during his administration of India, in 1351 volumes; and the papers of Sir Hudson Lowe during Napoleon's captivity at St. Helena, supply materials for history which have been already partly made use of. A miscellaneous collection, bequeathed by Sir Joseph Banks, contains, among other nautical journals, the log-book of Tasman, the discoverer of Van Diemen's Land, now named after him Tasmania. A collection of manuscripts on the affairs of Italy, in 604 volumes, purchased in 1830, at the sale of the Earl of Guildford's library, was followed in 1836 by 85 volumes of 'Relazioni' or reports to the Signory of Venice from their ambassadors, and in 1837 by 291 volumes of selections from the Canonici collection of Italian literature. In 1844 the Museum received by donation 96 volumes of Welsh manuscripts, from the Welsh school, and 128 from the Cymmrodorion Society, comprising the whole collections of both establishments, which had up to that period been almost inaccessible, because from their paucity it had been out of the question to pay a librarian to attend to them. They consist chiefly of transcripts made for the use of the editors of the 'Myvyrian Archæology.'

Of Oriental manuscripts, the Museum was enriched with two collections in the year 1825—one of 802 volumes of Syriac, Arabic, Persian, and Turkish, collected by Claudius Rich, the English consul at Bagdad, and described by him in the periodical called the 'Mines de l'Orient,' and another of 136 volumes, bequeathed by John Fowler Hull, a young Orientalist of fortune, who also bequeathed a collection of Chinese and Oriental printed books. In 1841 a collection was purchased of 49 volumes of ancient Syriac manuscripts, obtained by the Rev. Henry Tattam, from the monastery of St. Mary Deipara, in the desert of Nitria, about 70 miles from Cairo; and in 1843 another collection, obtained by the same gentleman from the same place, of 317 volumes. In 1847, a third collection of 173 manuscripts from the same library in the desert, was purchased of M. Pacho, a Frenchman. The curious history of the acquisition of these collections is given in some detail in an article in the 77th volume of the 'Quarterly Review.' When the second collection arrived at the Museum, very few of the volumes were perfect; nearly 200 had been torn up, it is said, into separate leaves, and then mingled apparently at random. The Rev. William Cureton, then assistant-keeper of the manuscripts, in the course of eighteen months disentangled the confusion, and has been fortunate enough to make three discoveries which he has published—of a copy of the Epistles of St. Ignatius, of palimpsest a portion of the Iliad, and of the Gospel of St. Matthew, in Syriac, by some supposed to be the language in which it was originally written. The volumes are found to consist, in the first two collections only, of upwards of 1000 different manuscripts, or portions of manuscripts, ranging from the year 411 to the year 1292. An augmentation of 236 oriental manuscripts was made in 1833, by a purchase from Mr. Rich, the American bookseller, of a collection formed by an American consul, and 245 Persian manuscripts were presented in 1847 by the sons of Major-General Yule. The result was, that in 1854 the number of manuscript volumes of Arabic was 1060; of Hebrew, 232; of Persian, 1082; of Sanskrit, 122; of Syriac, 631; of Turkish, 268; with small collections of different sizes, the lowest in number 12, and highest 83, of Ethiopic, Armenian, Burmese, Bugis, Cingalese, Hindustani, Javanese, Malay, Malayalma, Pali, Siamese, Tamul, and Telugu. A table of their numbers will be found in the 'Handbook to the Library of the British Museum,' by Richard Sims, of the department of manuscripts, a valuable little volume, which contains a variety of useful information with regard to the manuscripts, and to which we have been largely indebted.

A foreign authority, Dr. Pertz, librarian of the Royal Library at Berlin, has stated of the British Museum (in his 'Archiv für Geschichtskunde,' vol. ix), that "the number of manuscripts acquired since 1827 is very great; the establishment obtains information of every important sale on the continent, and it is easy to perceive that if affairs continue in their present course, every important manuscript in

Europe, that is not already locked up in fiscal collections or does not become so, will in the course of another century become the property of the British Museum." On the other hand, complaints have been frequently made in England that owing to the paucity of public grants, manuscripts which there was an opportunity of acquiring with a liberal expenditure, have been allowed to pass into private hands, where they are inaccessible except by private favour; and have been and often are locked up in "cold obstruction" by private caprice. The date assigned by Dr. Pertz for this new impulse is that of the appointment of the Rev. Josiah Forshall to the keepership of the manuscripts, and there can be no doubt of the increased activity of the department in the way of acquisition during his administration (1827–1837), and that of his successor Sir Frederic Madden. Some results of this activity have been already enumerated in the mention of the separate collections, others are brought to the cognisance of the public in the exhibition cases of the manuscript department, since that exhibition commenced in 1858. In these cases the 'Magna Charta,' the 'Alexandrian Codex,' the 'Durham Book,' and many of the other curiosities already mentioned, are laid open to public curiosity; and also a selection of autographs. There are those of English sovereigns from Richard II. to George III.; of several foreign sovereigns, including Charles V., the Czar Peter, Frederick the Great, and Napoleon; others of statesmen and warriors, including the last letter of Nelson on the eve of the battle of Trafalgar, and a calculation made by Wellington on the field of Waterloo; others of men of genius and world-wide influence, including Ariosto and Tasso, Luther and Calvin, Erasmus and Voltaire. There are also the original manuscripts of Tasso's Malpiglio, of some of Lope de Vega's plays, of Ben Jonson's Masque of Queens, of Pope's translation of Homer, of Sterne's Sentimental Journey, of Johnson's Irene, and of Walter Scott's Kenilworth, in the handwriting of their authors. There is the deed by which Milton assigned the copyright of 'Paradise Lost,' presented by Rogers, the poet, in 1852; and there is a mortgage deed with the signature of Shakspere, purchased in 1858. The mortgage is for 60*l.*; the signature, we believe, was purchased for 320*l.*

Department of Antiquities.—In the infancy of the Museum, the antiquities being few in number and of little value, were considered, with other artificial curiosities, as an appendage to the natural history; the coins, medals, and drawings of the Museum collection were at that time appended to the department of manuscripts; and the prints and engravings to the library of printed books. When, in 1772, a very considerable assemblage of articles of Greek and Roman antiquity, comprising the largest collection then known of ancient fictile vases, was purchased of Sir William Hamilton for 8400*l.*, the augmentations were not so numerous as to require an increase of the establishment. The arrival of the Egyptian monuments acquired by the capitulation of Alexandria, in 1801, which were ordered in the following year by King George III. to be placed in the British Museum, first suggested the erection of an additional edifice, rendered still more indispensable by the purchase of the Townley Marbles in 1805. Accordingly, upon the completion of the building intended for the two collections, a new department was created, in 1807, by the name of the Department of Antiquities, and the magnificent collection of ancient sculpture was at length opened for the inspection of strangers and the improvement of artists, an advantage which the students of the Fine Arts had never before enjoyed in this country. To this department the Hamilton vases and antiquities were transferred, together with the coins, medals, drawings, and engravings.

In 1814, a communication having been made by the Townley family that there still remained in their possession a very large collection of ancient bronze figures and utensils, of Greek and Roman coins, gems, drawings, &c., all of which might serve essentially to illustrate the sculptures purchased in 1805, the House of Commons granted in that year the sum of 8200*l.* for the purchase.

In 1815 the Prince Regent, at an expense of little less than 20,000*l.*, purchased and ordered to be deposited in the Museum an extensive series of sculptures, the frieze of the temple of Apollo Epicurius, at Phigaleia in Arcadia, which are known from Pausanias to be the genuine productions of the earlier time of the school of Phidias. To these, in 1816, was added the Elgin collection, which as contributing to the progress of the arts in this country, is the most important accession received by the Museum since its institution. It chiefly consists of the exquisite sculptures which once adorned the pediments and frieze of the Temple of Minerva, on the Acropolis of Athens. For the purchase of these, parliament voted the sum of 35,000*l.*

Since this period, many individual objects of much interest have been, from time to time, added to these collections: as, for example, a Cupid, from Mr. Burke's collection; a group of Mithras, bought of Mr. Standish; the Rondinini Faun; a Torso of Venus, which was injured by the fire at Richmond House; a statue of Hadrian; a bas-relief of the Apotheosis of Homer, purchased for 1000*l.*; a Venus of the Capitol, presented by King William IV.; while, in later years, the following great collections have been secured for the Museum, chiefly by the zeal and labour of English travellers.

I. The *Lycian Marbles*, procured during two expeditions in the years 1842-44 by Sir Charles Fellows, and consisting chiefly of reliefs from an Ionic edifice, and from the so-called Harpy Tomb, at Xanthus; together with a miscellaneous assortment of sculptures, some native

Lycian, but mostly Asiatic Greek, from different places at the S.W. angle of Asia Minor.

II. *Sculptures from the Mausoleum of Halicarnassus*, comprising eleven bas-reliefs, with combats of Greeks and Amazons; procured for the Museum through Sir Stratford Canning, at that time H. M. Ambassador at Constantinople.

III. *Sculptures from Nineveh*, obtained by a series of excavations conducted during 1847-50 by A. H. Layard, Esq.; and, on his return to Europe, between the years 1851-56, by H. Rassam, Esq., and W. K. Loftus, Esq. A collection comprising the results of very extensive excavations at Nimrud (the Calah of the Bible), Koyunjik (Nineveh), Kalah Sherghat (Assur); together with a large assortment of miscellaneous antiquities from Babylon, Birs-i-Nimrud (Borsippa), and from many ancient sites in Southern Chaldæa, including those of Warka (Erech), and of Mugaher (Ur of the Chaldees). To exhibit these monuments in some degree, a suite of three long narrow rooms, originally intended for other purposes, exceeding 300 feet in length, has been made use of, with an additional transept at their southern end, together with a large room in the basement of the building. In these rooms the sculptures have been arranged, so far as has been possible, chronologically; an arrangement, however, which is far from complete, owing to the contracted nature of the space devoted to these monuments. With these may be noted a collection of Persepolitan marbles, presented in 1825 by Sir Gore Ouseley, forming a valuable addition to some which had been previously presented by the Earl of Aberdeen.

IV. A much larger collection of sculptures and other antiquities, excavated by C. T. Newton, Esq., H.M. vice-consul at Mytilene, on the site of the *Mausoleum of Halicarnassus*, during the years 1856–58, and comprising many additional slabs from the frieze, two colossal statues (probably those of King Mausolus and of his Queen Artemisia); together with portions of two colossal horses, and of the quadriga which surmounted the edifice; with columns, capitals, and other architectural members in sufficient number and perfection to render it possible for any well-informed architect to reconstruct the original building.

V. A curious collection (also procured by C. T. Newton, Esq., during the years 1857–58) from the site of the Temple of Apollo at Didymi, near Miletus, and from Cnidus, embracing several sitting figures of the earliest Greek art, which were originally placed in the *Sacred Way* leading up to the Temple of Apollo from the sea; together with an inscribed lion, and other inscriptions in the Archaic Greek character. From Cnidus, Mr. Newton has sent home a magnificent colossal lion, with many other interesting fragments of sculpture.

VI. A large number of mosaic pavements, and nearly 100 Phœnician inscriptions, excavated on the site of ancient Carthage, by the Rev. Nathan Davis, in the years 1856–59. The pavements, many of which are in excellent preservation, are unquestionably Roman, and perhaps not earlier than the 2nd or 3rd century A.D. Many however of the Phœnician inscriptions may fairly be presumed to have belonged to the ancient Carthaginian people, before the destruction of Carthage by Scipio. For the appropriate exhibition of these large and important collections, no provision can be made within the limits of the present building. It has been therefore found necessary to place Mr. Newton's sculptures for the present in a glass shed erected under the columns in the portico, while Mr. Davis's Carthaginian antiquities may be found in an unoccupied part of the basement, to the right of the new Nineveh Room.

Coins and Medals.—The foundation of this part of the collection was laid in the cabinets of Sir Robert Cotton and Sir Hans Sloane. More than 6000 ancient medals were purchased with the Hamilton collection in 1772. In 1799, a collection of coins and medals, estimated at the value of 6000*l.*, was bequeathed to the Museum by the Rev. Clayton Mordaunt Cracherode. In 1802 the trustees purchased the most complete series of Anglo-Saxon coins then known, which had belonged to Samuel Tyssen, Esq., for 620*l.* In 1810 a series of the coins of England from the Conquest to the reign of George III., which had been made by Edward Roberts, Esq., of the Exchequer, for his son, was purchased for the sum of 4000 guineas; and about the same time a series of papal medals for 135*l.*, and a collection of Greek coins from Col. de Bosset for 800*l.* In 1814 the Townley collection of Greek and Roman coins (particularly rich in Roman large and second brass) was added by vote of parliament, and a collection of Greek coins offered for sale by Capt. Cust, was purchased by the Treasury for the sum of 630*l.* Another considerable as well as choice collection of Greek coins was obtained at the time of the purchase of the Elgin marbles. In 1818 Lady Banks presented all such coins and medals belonging to the extensive cabinet of Mrs. S. S. Banks as were not previously in the Museum, including a considerable collection of foreign coins. In 1824 Mr. R. Payne Knight bequeathed his Greek coins to the Museum, which, joined to the Greek coins already in the cabinets, made the Museum series of kings and cities superior even to the celebrated collection of the King of France. In the following year King George IV. presented to the Museum a cabinet of coins and medals which had been attached to the library of George III., which contained a valuable assortment of German coins, and of the medals of the illustrious men of Italy. During more recent days vast additions have been made to the collection of Greek and Roman coins by purchases at several important sales, such as those of the Duke of Devonshire,

Messrs. Trattle, Borrell, Thomas, Boyne, Campana, Rollin, Durrant, Cuff, &c., or from individual collectors, such as Messrs. Burgon, E. Thomas, &c., by means of which the ancient collections in the Museum have been placed on an equality with those of any European cabinet. Much, too, has also been added by the generosity of individuals, especially in the case of coins belonging to England; thus, 174 coins of the Anglo-Saxon series, found at Dorking in Surrey in 1818, were presented by Robert Barclay, Esq., of Bury Hill, and George Dewdney, Esq., of Dorking; a large collection of the coins of the first two Edwards, found at Tutbury in Staffordshire, in June, 1831, by Lord Holland, chancellor of the duchy of Lancaster, together with the produce of a find at Cuerdale in Lancashire, in May, 1840, consisting of ingots of silver armillæ, &c., weighing nearly 1000 oz., and between 6000 or 7000 coins (the most important of which were presented to the Museum by the Chancellor of the Duchy of Lancaster). The English collection of coins has also been enriched simultaneously with the classical, by large purchases, often from the same sales, and also by accidental purchases, such as that of a selection from 5700 pennies found at Tealby in Lincolnshire in 1814; 296 coins of the Styca series, found at Hexham in 1832; and 659 varieties of the money of William the Conqueror, discovered at Beaworth in Hampshire. The result has been that, in coins relating to Great Britain, the collection in the British Museum is, as it should be, unrivalled.

The Oriental collection of coins, now extending to 16,000 or 17,000 pieces, is of the most recent growth. Originally founded in a few specimens procured by Sir Hans Sloane, it remained unincreased till 1825, when a large assemblage of Mohammedan and other coins were purchased by Parliament for 1000*l.* of C. J. Rich, Esq. This collection was greatly augmented by the magnificent bequest of his cabinet of Oriental coins by William Marsden, Esq., in 1834. This beautiful collection, the whole of which had been arranged and described by its owner, consisted of nearly 3500 specimens, one-fifth of which were in gold. Since then, large accessions have come to this series; by the purchase of the cabinets of the late James Prinsep, Esq. (comprehending many of the earliest discovered Bactrian coins); by those of Edward Thomas, Esq., H.E.I.C.S., and Major Cunningham; and by extensive purchases at the sales of Messrs. Pietraszewski, Bird, &c.

The whole of these collections—the Ancient, Mediæval, Modern, and Oriental—are now preserved in one room called the Medal Room; no space having been as yet found in which any of the coins can be exhibited to the public.

In a room behind the Medal room are preserved an admirable assemblage of engraved gems, chiefly procured by Sir W. Hamilton, the Rev. C. M. Cracherode, and Charles Townley, Esq.; the Portland Vase, lent for exhibition by the Duke of Portland; together with a collection of gold ornaments, rings, &c., from the tombs of Ancient Etruria, from Wales, from the bogs of Ireland, &c. Here also are now exhibited some miscellaneous objects formerly kept in the Medal room, as the snuff-box of Napoleon the Great, presented by him to Lady Holland; another, bearing his portrait, given by him to the Hon. Mrs. Damer; a watch, said to have been that of Oliver Cromwell; a gold inlaid ring, bearing the name of Ethelwulf Rex; and a gold breastplate, found at Mold, in Flintshire, probably once the property of a British or Celtic chieftain.

The Egyptian Collections, which are now arranged in one large saloon on the ground floor, and in two smaller rooms up-stairs, is mainly founded upon the great monuments of that country, collected by the French savans during the occupation of Egypt by the army of Napoleon, and ceded to England at the capitulation of Alexandria in 1801. From this time no material additions were made to this part of the department of antiquities; but in 1817 the upper part of a fine colossal statue, commonly though incorrectly called the Memnon, taken from Thebes by Belzoni, was given to the Museum in the joint names of Henry Salt, Esq., the British consul at Alexandria, and Louis Burckhardt, Esq. In 1823 the trustees, by the aid of parliament, obtained Mr. Salt's first collection of Egyptian antiquities (exclusive of an alabaster sarcophagus, afterwards purchased by Sir John Soane) for 2000*l.* Another collection, particularly illustrative of the domestic manners of the ancient inhabitants of Egypt, belonging to Mr. Joseph Sams, was purchased by parliament in 1834, for 2500*l.*: a considerable number of antiquities of the same description were presented to the Museum in the same year by J. G. Wilkinson, Esq., and in 1835 a still larger accession was obtained by an expenditure of 5081*l.* 16*s.*, at the sale of Mr. Salt's third collection of antiquities, including numerous papyri which have been since unrolled. In this year also Lord Prudhoe presented to the Museum the two fine lions of red granite which his lordship had procured at Jebel Barkal in Nubia. From that time to the present day, no year has passed without considerable additions being made to the Egyptian collection; these have, however, been for the most part objects small in size, such as scarabæi, gems, bronzes, and vitreous ornaments, together with many papyri, in which ancient writings the Museum is now very rich.

Besides the Egyptian, Assyrian, and Classical monuments already noticed, two rooms on the upper story are now appropriated to the Græco-Italian vases, a class of which the Museum possesses the most valuable and interesting assemblage in the world, with the exception of that in the Museo Borbonico at Naples. A portion of another room has been devoted to the exhibition of a noble collection of miscellaneous antiquities, formed by the late Hon. Sir William Temple, during twenty years in which he held the office of H.M. minister at the court of Naples, and munificently bequeathed by him to his country at his death in 1856. A third room contains a very valuable collection of bronze statuettes, vases, ornaments, articles of domestic use, candelabra, helmets, &c., founded originally on those which had belonged to Sir W. Hamilton and Mr. Townley, but largely increased in 1824 by Mr. Payne Knight's bequest of his bronzes, 798 in number,—the finest collection which has ever been brought together by one man. In this room also are preserved the bronzes of Siris, so called because stated to have been found in 1820 near the river of that name, which were purchased in 1833 by subscription for 1000*l.* of the Chev. Bröndsted. Since this period many excellent individual specimens have been placed in this room, and especially the contents of a very ancient Etruscan tomb, from the necropolis of Vulci, known as "La Polledrara;" and an attempt has been made to arrange the various objects in it according to the principles so admirably laid down in C. O. Müller's 'Hand-book of Ancient Art.' A fourth room, called the British and Mediæval room, adjoining the bronze room, contains a large and miscellaneous collection of objects, comprising,—1. British antiquities anterior to the Romans, flint knives, arrow heads, stone hammers, bronze implements, swords, shields, spears, daggers, &c.; Roman antiquities, glass and earthenware vessels from tombs, pottery, Samian and Arretine ware, roof and flue tiles. With these are arranged the bulk of Mr. Roach Smith's collections, as peculiarly illustrative of *Roman* London. 2. Anglo-Saxon antiquities, weapons, urns, &c., from ancient cemeteries. 3. The Mediæval collection, comprising metal work, paintings from St. Stephen's chapel, Westminster; ivory carvings of great beauty from the 14th to 17th centuries; enamels, English pottery, German and Venetian glass, and a rich collection of Majolica, many fine specimens of which were procured at the sale of Mr. Bernal's collection, and Flemish stoneware.

Print Room.—In the Department which contains drawings and engravings there are one or two superb drawings by Rubens; a large collection of drawings of the Italian school; three volumes, a part of Mr. R. P. Knight's bequest, containing 272 original drawings of Claude Lorraine; a numerous assemblage of drawings of the Dutch school; several hundred drawings by Albert Durer and other old German masters; a large collection of Van Huysum's drawings of plants, which formerly belonged to the Sloane collection; a collection of drawings of plants and costumes by native artists of China; Parr's and Revett's views in Greece and Asia Minor, chiefly architectural, in two volumes, accompanied by a third volume, containing Towne's views in Rome and its vicinity; three volumes of highly-finished drawings in black chalk, copied from the most celebrated pictures in Rome, and accompanied by an extra volume after the frescoes of Guido in the private chapel of the Vatican, by Mosman; these were presented to the Museum by the Earl of Exeter, and cost nearly 3000*l.* There is also a large collection of drawings from antique marbles, gems, &c., formerly belonging to Mr. Charles Townley; and there are two folios of drawings made under the direction of the Earl of Elgin at Athens.

In the collection of prints, among numerous impressions of the works of Niello, is a sulphur of the celebrated Pax by Maso Finiguerra, of the Assumption of the Virgin, anno 1452, purchased in 1835 for 270 guineas. The prints of the different masters are for the most part arranged in schools, as the Florentine school, the school of Siena, the Roman school, the Bolognese, Lombard, and Venetian schools, the schools of Genoa and Naples, the French school, &c. There are large and almost complete collections of the works of Marc Antonio, Benasoni, Rembrandt, and Hollar; a very fine and extensive assemblage of Hogarth's prints, the foundation of which was laid in 1823 by the purchase of Mr. Packer's collection, of Dunmow, for 315*l.*; a Granger collection of English portraits of great extent; a very large collection of early German prints in wood; an almost perfect collection of prints engraved after the pictures of Sir Joshua Reynolds; a large collection of Bartolozzi's engravings; Dr. Burney's collection of theatrical portraits; an immense collection of foreign portraits, purchased with the library of the Baron von Moll, of Munich; and a Pennant's 'History of London,' illustrated with prints and drawings, in fourteen volumes in folio of the largest size, made by the late Mr. Cole at an expense of 7000*l.*, by whom it was bequeathed to the Museum.

In the print room also is preserved one of the most wonderful specimens of art, in a carving in stone by Albert Durer, in alto-rilievo, representing the birth of St. John the Baptist, dated 1510, for which Mr. Knight, who bequeathed it to the Museum, gave 500*l.*

In 1836 this department was considerably enriched by the purchase of the Sheepshanks collection of Dutch etchings for the sum of 5000*l.* It was described by the then keeper of the department, Mr. Josi, in his evidence before the select committee of the House of Commons in the same year, as more perfect than any similar collection existing at Vienna, or at Paris or Amsterdam. The entire collection embraces as many as 8450 engravings and drawings, bound in thirty-two volumes. The sum annually allowed at that time for the purchase of prints and drawings amounted only to about 250*l.*, which has since been increased to 1200*l.* or 1500*l.*, and has occasionally even reached as high as 2000*l.* This is exclusive of any special grants for extraordinary purchases, like that of the Sheepshanks collection.

The more recent acquisitions of importance in this department are:

a collection of engravings by Cornelius and Jan Visscher, in 1840; a collection of 209 portraits, published by Messrs. Paul and Dominic Colnaghi, who presented them to the Museum, in 1842; "a most valuable purchase," made in the same year, "out of the collection late the property of Mr. Harding, consisting of the finest specimens of the works of the early Italian and German masters, etchings by Rembrandt, many of them in a unique state, and some splendid specimens of engravings by Wille, Woollett, Muller, Langhi, Bewick, &c., comprising 321 pieces." These were purchased for the sum of 2390*l.* In 1843 a collection of Raphael Morghens was acquired for 1575*l.*; and in 1845 a collection of early German engravings was obtained for 2830*l.*, and of Italian for 4875*l.* These are described in the Parliamentary return as follows:—"A curious collection of the prints of the earlier German engravers, amounting to 1755 in number; amongst them will be found no fewer than 164 specimens by the Master of 1466 and the artists of that period;" and "An uncommonly fine collection of early Italian art, embracing the most extensive collection of the workers in nielli known. It consists of 103 specimens in silver, 15 impressions in sulphur, and 63 impressions on paper. In 1848 there was added another large collection of etchings and drawings, purchased from the Messrs. Smith for 4200*l.* In 1851, a collection of caricatures by Gillray, 1398 in number, was presented by W. Smith, Esq.; and in 1853, a collection of original drawings made by Sir Wm. Gell, amounting in number to 800, was bequeathed by the late Hon. R. Keppel Craven.

In the report of the Royal Commissioners of Inquiry into the British Museum, a recommendation was given to exhibit some of the engravings to the public. In compliance with this recommendation, a selection from the prints and drawings is now exhibited in the King's Library, the arrangement of which is as follows: *—

"Four screens have been fixed on each side; those on the left hand (when entering from the Manuscript department) being appropriated to the exhibition of drawings; those on the right to the display of engravings. The space available for the exhibition of these objects being necessarily circumscribed, the purpose has been to offer such a selection as shall give to the public an opportunity of tracing the development of design as shown in the sketches and studies of the great masters of Italy, Germany, Flanders, and Holland, during the 15th, 16th, and 17th centuries. Screens I. and II. are devoted to the schools of Italy; III. and IV. to those of Germany, Flanders, and Holland. With respect to the engravings, it will be seen that the arrangement is such as will afford the opportunity of comparing the contemporaneous productions of the principal masters of the schools of Italy, Germany, Flanders, and Holland, from the middle of the 15th to the end of the 16th century. These are followed by a selection of a few of the most successful efforts of the Dutch and Flemish engravers of the 17th century, with specimens of etchings by their most distinguished painters, who so enthusiastically and so successfully practised that branch of art at the same period. Some fine examples by the Italian workers in niello, consisting of engraved silver plates, sulphur casts, and impressions on paper, are shown in the glazed cases marked I. and II., and in III. and IV. are early Italian and German wood blocks, printed in chiaroscuro."

Among the drawings thus exhibited will be found admirable specimens of Giotto, Fra Angelico, Masaccio, Filippo Lippi and Filippino Lippi, Paolo Uccelli, Sandro Botticelli, Michel Angelo, Lorenzo Credi, Fra Bartolommeo, and Andrea Del Sarto, all of the Florentine School; of Perugino, Raffaelle, Giulio Romano, Muziano, and others of the Roman School; of Giovanni and Gentile Bellini, Giorgione, Campagnola, Tiziano, Paolo Veronese, Tintoretto, Bassano, and Canaletto of the Venetian School; of Leonardo da Vinci, and Gaudenzio Ferrari, of the Milanese School; of Correggio and Parmigiano, of the Parmesan School; and of Francia, the three Carracci, Guido, and Guercino, of the Bolognese School. Among the drawings of the German masters are placed some fine examples of Michael Wohlgemuth, Schongauer, Peter Vischer, Albert Durer, Hans Holbein, Grun, Burgkmair, Altdorfer, and Rottenhamer. The Flemish and Dutch artists are well represented in a collection of drawings by Vander Weyde, Hans Memling, Mabuse, Heemskerk, Breughel, Bril, Rubens, Van Dyck, Snyders, Rembrandt, Bol, Ruysdael, Ostade, Van de Velde, Bakhuyzen, Berghem, Paul Potter, and Cuyp. While this collection of drawings, as a whole, illustrates the history of art, many of the specimens that it contains are in themselves highly beautiful, both for design and execution.

The collection of nielli and of sulphur casts in the British Museum is well known to be the finest in the world. Some fine specimens of Maso Finiguerra, the most renowned worker in this branch of art, the parent of engraving, will be found in this exhibition; together with some impressions on paper from works in niello by Finiguerra, Peregrino da Cesena, Francia, and others.

Among the engravings there are several examples of the Italian School, commencing with Baccio Baldini, and including Botticelli, Campagnola, Mantegna, Pollajolo, Leonardo da Vinci, Raimondi, the "Master of the Die," and numerous others. The examples from the German, Flemish, and Dutch schools are still more numerous; embracing

* 'A Guide to the Drawings and Prints exhibited to the Public in the King's Library.'

specimens of the "Master of 1466," of Martin Schongauer, Martin Zagel, Albert Durer, Lucas Van Leyden, George Pencz, Goltzius, Muller, Rubens, Van Dyck, Paul Potter, Teniers, Ostade, and Rembrandt. Of the last mentioned there are exhibited some of the finest etchings that the Museum or the world has to show, two of which must be particularly mentioned, namely, No. 212, "Christ healing the Sick: first state, known as the hundred guilder piece, it having sold for that price (equal to about eight guineas,) during the life-time of the painter;" also, No. 217. "Portrait of Ephraim Bonus, an eminent Jewish Physician of Amsterdam: first state, with the black ring, only three other impressions being known."

Departments of Natural History.—Sir Hans Sloane's collection of objects of natural history, which, however insignificant it may now appear, was very considerable for the time when it was brought together, forms the nucleus of the present extensive departments of *Zoology, Palæontology, Mineralogy,* and *Botany.* It consisted of quadrupeds and their parts; birds and their parts, eggs, and nests; amphibia, crustacea, shells, echini, entrochi, insects, corals, sponges, zoophytes, stones, ores, bitumens, salts, and an extensive herbarium. But to this department also, in the infancy of the Museum, all miscellaneous artificial curiosities were consigned, with a few antiquities and a collection of anatomical preparations, all of which have since been separated from it.

The science of natural history, however, in course of time, made such rapid progress, that the collection of Sir Hans Sloane, which when purchased was deemed of the first magnitude, declined in its comparative value with respect to every one of its departments.

To supply its deficiencies, the trustees, in 1769, purchased a collection of well-preserved stuffed birds which had been brought over from Holland, for 460*l.* Many additions were afterwards made by purchase and donation. The voyages of discovery early in the reign of George III. brought numerous acquisitions; and in 1816 a rich collection of British zoology, which had belonged to Col. Montague, of Knowle in Devonshire (including a very large number of birds), was purchased for 1100*l.* A valuable collection of stuffed birds was bequeathed to the Museum in 1835, by the late Major General Hardwicke. Since that time still larger acquisitions have been made by presents and purchase, in the class of ornithology, so that the aggregate now forms a collection, not indeed complete, but as extensive as most of the collections in Europe.

Similar progress has been made in increasing the collections of mammalia, fishes, reptiles, insects, and crustacea in the British Museum. With regard to the extent of these collections in 1849, Dr. Gray submitted the following statement to her Majesty's commissioners of inquiry into the constitution and management of the British Museum: "In 1836, Mr. Gray gave some account of the state of the Museum collections, compared with those on the Continent. Since that period he has had the opportunity of again inspecting those collections, and others in the south and eastern parts of Germany, and the south of France, which he had not then seen, and he considers the statements made at that time to require no corrections; but the comparison is now much more favourable for the British Museum, that collection having been increasing very rapidly,—indeed in a most unexampled manner,—while most of the continental collections have for the last six or seven years, for some political reason, been nearly stationary; or, at most, increasing a single part of their collections, or receiving specimens from a single locality where they happened to have a collector staying. To enter into a few details, Mr. Gray believes that the Museum collections of mammalia, birds, shells, and lepidopterous insects, are much more extensive than any other public collection, and superior to all the public collections together. This is certainly the case with the first and last mentioned groups; and he believes also with the other two. The collections of reptiles, fish and crustacea, are only second to those at Paris, if at all below them; but Cuvier, and Valenciennes, and Dumeril, and Bibron, and M. Milne Edwards, having for years been engaged in works on those three classes, they have concentrated their attention on increasing them, and have received specimens from all parts of the world, for the purpose of enabling them to complete their labours, which makes it probable that their collection is richer in these classes. The Museum collection in each of these classes contains many species which the Paris collection wants. The Museum collection of insects, taken as a whole, is much larger and better arranged than that of Paris. In some parts, the Berlin collections exceed it. The collections of corals, sea-eggs, and star-fishes, are very large, far larger than those of all the other European collections together." Since the time when this evidence was submitted to H. M.'s commissioners, the collections in the British Museum have continued to increase both in number and importance.

For this, much is due to the additional stimulus given to the study of natural history through our free intercourse with the public and private museums on the continent, ever since the close of the war in 1815; but a great deal also to the energy and skill of the present keeper of the zoological department, Dr. John Edward Gray, and of his able assistants, Messrs. George Gray, Adam White, Dr. Baird, and Frederick Smith. Dr. Gray succeeded to his present office upon the retirement of the late Mr. Children, in 1840; since which time it is that the Museum collections of zoology have taken the rank that they

at present occupy, of being among the first in the world, both for extent and accurate scientific arrangement. To take the department of entomology alone, it will be found that there are at present, at the lowest computation, upwards of a million of specimens, all classified and labelled, in a manner to make them at once available to the student. These have been acquired at different times, and in different ways which it would take long to specify; but it may at least be mentioned that in 1853, the Museum obtained the collection of British insects belonging to the late Mr. James Francis Stephens, one unrivalled in extent, amounting to 88,000 specimens, for the small sum of 400*l.* And since that time it has purchased the collections of Coleoptera, formed by Messrs. Märkel and Braasche, in order to have a *European* collection to compare with the British. The collection of shells in the Museum is very extensive, and would eclipse any yet known, had Dr. Gray's recommendation been complied with by the Treasury, for the purchase of Mr. Cuming's collection, offered to the Museum a few years ago for the sum of 6500*l.* It needs only further to be stated, that the zoological collections generally have been much augmented by specimens obtained from the commanders of the several exploring expeditions, as those of the Erebus and Terror, Samarang, Rattlesnake, Beagle, &c.

The additions made during the past year (1858), amount to as many as 42,691 specimens, of which there are 6,180 belonging to the class *vertebrata*, 7,812 to the *mollusca* and *radiata*, and 28,699 to the *annulosa*. Of these, a collection of mammalia, birds, reptiles, fish, shells, crustacea, and insects, formed by F. M. Rayner, Esq., Surgeon, R.N., during the voyage of H.M.S. Herald, in the Fiji group, and other islands of the Pacific, was presented by the Lords of the Admiralty; and a collection of mammalia, birds, reptiles, and their skeletons, as also a series of human skulls from Nepaul, presented by the late resident, B. H. Hodgson, Esq. (See 'Parliamentary Returns, June 1859.)

The method of exhibition to the public, according to the last published 'Guide to the Exhibition Rooms of the British Museum,' is as follows: "The collection of animals is contained in three galleries, and, for the convenience of exhibition, is arranged in two series. The beasts, birds, reptiles, and fishes, are exhibited in the wall cases. The hard parts of the radiated, molluscous, and annulose animals (as shells, corals, sea-eggs, starfish, crustacea), and insects, and the eggs of birds, are arranged in a series in the table cases of the several rooms.

"The names and numbers of the rooms are placed over the doorways in each apartment, and the numbers of the cases over the glass frames.

"The specimens are labelled with the scientific name, the English name when they have one, the country whence they come, and, when they have been presented, with the name of the donor.

"The general collection of mammalia, or beasts which suckle their young, is arranged in three rooms, the hoofed beasts (*ungulata*) being contained in the central saloon and southern zoological gallery, and the beasts with claws (*unguiculata*) in the mammalia saloon."

The insects and crustacea, with the exception of those exhibited in the table-cases in the northern zoological gallery, are for the most part preserved in cabinets in a room on the basement floor, in the north-west angle of the building, and may be seen by persons wishing to consult them for purposes of study, every Tuesday and Thursday on application to the keeper.

The collections of *Palæontology* and *Mineralogy* in the British Museum have also progressed in a ratio quite equal to that of zoology. The first-named of these sciences, which scarcely had an existence when the Museum was founded, is now admirably illustrated by the numerous specimens of organic remains acquired during the last thirty years. Before mentioning these, however, it should be stated that two rather notable acquisitions were made at an early period; namely, of a collection of London clay fossils, from Hampshire, found and described by Solander, and presented to the Museum, in 1766, by Gustavus Brander, Esq., at that time one of the trustees; and the collection, known by the name of the 'Beroldingen Fossils,' acquired by purchase in 1816. In 1839, the collection was much enlarged by the purchase of Dr. Mantell's celebrated museum; and in 1835 and 1840, by those of Mr. Thomas Hawkins, containing some of the finest specimens of ichthyosauri and plesiosauri ever discovered. Numerous other additions have since been made; among which must be specified a remarkable collection of fossil remains of birds discovered in New Zealand by Mr. Walter Mantell, and sold to the Museum by his father.* "These bird remains are referred by Professor Owen to several species, and indeed to distinct genera of birds, some of which are still living in New Zealand, whilst others are, most probably, extinct. Amongst the living species may be noticed the *Notornis Mantelli*, a very large species of the rail family. The first indication of this bird was given by some fragments of the skull found with remains of other birds in superficial deposits of New Zealand by Mr. W. Mantell in the middle island of New Zealand, and the specimen which he obtained is now deposited in the Museum. The greater portion of the bones, as determined by Professor Owen, belong to a genus of birds to which the professor has applied the name of *Dinornis*." An entire skeleton of one of these, the *Dinornis elephantopus*, has been put together by Professor Owen, and is now

* Guide to the Exhibition Rooms, &c.

exhibited in the same room as the huge mastodon and megatherium, together with the legs of a second species, the *Dinornis giganteus*, which must have been from ten to eleven feet high.

Among the more recent accessions may be mentioned the Croizet collection of mammalia from Auvergne, acquired in 1848; the Dixon collection of chalk and tertiary fossils from the south of England in 1851; the Des Hayes collection of older and middle tertiary fossils, from Bordeaux, and the Paris basin, acquired in 1854; Major Cautley's collection of fossil bones from the Himalayas; the Tesson collection of oolites from Normandy, in 1857; and the Bruckmann collection of fossil plants from Œningen, in 1858. The fossils and minerals together occupy a long gallery called the 'North Gallery,' in the upper story of the building, divided into rooms numbered I. to VI. "The floor of the gallery is occupied by table-cases, which in the rooms I. to IV. contain the collection of minerals; and in rooms V. and VI. are devoted to the fossil remains of invertebrate animals. The wall-cases throughout the gallery are occupied by fossils. The fossil remains are arranged partly in zoological order and partly in geological sequence." They comprise plants, fishes, reptiles, mammalia, insects, and crustacea. These are all arranged in the most approved scientific order, and the collection altogether is, without exception, at present the finest in the world. The unscientific visitor will doubtless admire most the remains of the *Edentata*, quadrupeds without front teeth, as the megatherium; and the *Pachydermata*, or thick-skinned herbivorous quadrupeds, such as the elephants and mastodons, of which there are some very grand specimens in room VI. Another object of attraction in this room, besides the *Dinornis*, above mentioned, is the fossil human skeleton brought from Guadaloupe by Sir Alexander Cochrane, and presented to the Museum by the Lords Commissioners of the Admiralty. This was found imbedded in the solid limestone rock, and much discussion has arisen as to its antiquity, but the most probable conjecture is that it is not more than a few centuries old.

The specimens of *Minerals* in Sir Hans Sloane's Museum were collected at a period when the science of mineralogy was but little studied. Most of them had been chosen for him by persons of little skill, or had been intended to elucidate some system which had become obsolete. For a long time it made little progress, but in 1797, a small collection, made on the north-west coast of America by Mr. Menzies, who accompanied Capt. Vancouver as a naturalist, was presented to the Museum by George III. This collection contained little that was particularly curious, except that it supplied a kind of mineralogical history of an extensive but little explored coast. A systematic collection of minerals for the benefit of persons pursuing the study of mineralogy was not attempted by the trustees till 1799, when they supplied the deficiency of that branch of their institution by acquiring, at the price of 700*l.*, a well-chosen collection of minerals of every class, consisting of 7000 specimens, which had been made by Charles Hatchett, Esq., during his travels in various parts of Europe. All that was valuable of the Sloanean collection was incorporated with this ample accession, and with the addition of what the Rev. C. M. Cracherode's bequest afterwards supplied, formed, even before the addition of the Greville minerals, a copious and useful mineralogical collection. In 1810 an opportunity presented itself of acquiring the collection of minerals formed by Col. Greville, which were purchased by vote of parliament for 13,727*l.*: and to these collections George IV. added a large and splendid collection of minerals from the Harz Mountains formerly preserved in the Observatory at Richmond.

Two of the greatest rarities of the mineralogical collection are the sculptured tortoise in the centre of the gallery, wrought in Nephritic stone, and found on the banks of the Jumna, near Allahabad, in Hindustan; and a large specimen of meteoric cellular native iron from the province of Atacama, in Peru. There are, however, other specimens of the meteoric iron, some of which have been found in our own country. There are also various beautiful specimens of copper, gold, and silver. "The Siberian and Australian gold regions are well represented, and in particular, the produce of the Victoria gold district of Australia is exemplified in the Latrobe nugget, a mass of *crystallised* gold, of great purity and beauty, weighing nearly twenty-four ounces." The various other minerals, including what are commonly called *precious stones*, are also fitly represented in the Museum collection of mineralogy, which is continually receiving accessions, either by donation or purchase.

The system hitherto adopted for its arrangement, with occasional slight deviation, is that of Professor Berzelius, founded upon the electro-chemical theory and the doctrine of definite proportions as developed by him in a memoir read before the Royal Academy of Sciences at Stockholm in 1824. The detail of the arrangement is supplied by the running titles on the outsides of the glass cases, and by the labels within them. There being, however, good reason to suppose that the existing classification is not fully in accordance with the present advanced state of the science, a re-arrangement of the whole collection is contemplated. "But," as stated by the keeper in the parliamentary return just issued (June, 1859), "for such an arrangement to be complete, the collection will need the addition of a considerable number of minerals, either inadequately represented now or not represented at all. The exact and definitive arrangement of a large number of minerals will be impracticable until the means are furnished to the department

for examining the minerals by those chemical, crystallographic and optical methods, which in the present advanced state of mineralogy, are indispensable for their exact discrimination. Until there is a proper room for chemical, as well as one for crystallographic and optical researches, the arrangement of the minerals can only be provisional."

Botany.—The present extensive collection of dried plants, and other botanical specimens in the British Museum, had its origin in the collection of herbaria, formed from time to time by Sir Hans Sloane during his long life; or at least from the year 1687, when he went out to Jamaica as physician to the Duke of Albemarle, his chief inducement being the opportunity that it would afford him of studying his favourite science. In fifteen months' time he returned to England, bringing with him a collection of 800 species of West India plants, and thus laid the foundation of what was afterwards to become a highly valuable and extensive collection.

The Sloanean herbaria are contained in 336 volumes, bound in 262, and consist of Sir Hans Sloane's collections made by himself in Jamaica and elsewhere, and of various others presented to or purchased by him. Of the latter the most considerable are those of Plukenet and Petiver. Among them there are also large collections made by the Duchess of Beaufort, Kiggalaer, Buddle, Uvedale, and Hawkins; together with numerous smaller ones obtained from many of the principal botanists and travellers of the day. The most interesting are from the collections of Merret, Cunningham, Hermann, Bobart, Bernard de Jussieu, Tournefort, Scheuchzer, Kamel, Vaillant, Kæmpfer, Catesby, Houston, and Boerhaave, with the plants presented to the Royal Society by the Company of Apothecaries, in pursuance of the directions of Sir Hans Sloane, for the years 1722-1796. These formed the rent which the Apothecaries' Company paid for the Botanic Garden at Chelsea. The seeds and fruits of Sir Hans Sloane's collection are also extensive and well preserved.

The herbarium of the Baron von Moll, of Munich, in 48 portfolios, was added to the botany of the British Museum in 1815; after which time nothing of importance was received until the acquisition of the Banksian collection in 1827.

The Herbarium of Sir Joseph Banks, of which the larger and arranged portion is contained in cabinets, comprises upwards of 30,000 species. It consists of Sir Joseph's own collections, made during his voyage with Captain Cook; of the Herbaria of Cliffort, Hermann, Clayton, Aublet, Miller, and Jacquin; with many of the plants collected by Tournefort, and described in his 'Corollarium.' Aublet's plants were from French Guiana; the collections of Cliffort and Hermann were those from which Linnæus formed his 'Hortus Cliffortianus' and 'Flora Zeylanica.' Clayton's Herbarium was that from which Gronovius formed his 'Flora Virginica.' It comprises also the plants collected in the various voyages of discovery subsequent to Sir Joseph Banks's own, with the contributions of numerous travellers; and a collection of plants sent by Loureiro from Cochin China. The Banksian collection alone formed at one time the most valuable assemblage of dried plants in Europe, and is still one of the most important, not only on account of its extent, but as containing the original and authentic specimens of many published species. A collection of flowers and fruits, chiefly of the more rare or succulent plants, preserved in spirits, also form a part of the Banksian department, to the number of upwards of 300 bottles, with a collection of seeds and fruits in a dried state. After the arrival of Sir Joseph Banks's collection, an extensive series of plants was presented by the East India Company, formed and distributed by Dr. Wallich; and another collection of Egyptian plants was presented by Sir J. G. Wilkinson. Numerous additions have been made during the last twenty years, partly by donation and partly by purchase. Among these may be mentioned, a collection of the plants of the East, formed by Aucher-Éloy; of the plants of Greece, by Heldreich; of Persia, by Kotschy; of Siberia, by Karelin and Kirilow; of India, by Drs. Hooker and Thomson; of China, by Fortune; of the Philippine Islands, by Cuming; of Java, by Dr. Horsfield; of New Holland, by Drummond and others; of New Zealand, by Dr. Hooker; of Western Africa, by Don and others; of Southern Africa, by Zeyher and Burke; of North America, by Richardson and others; of California, by Douglas; of Texas and Mexico, by Wright and Fendler; and of Brazil, by Gardner and Spruce.

The additions obtained from these various sources make the entire number of species amount to about 50,000,—sufficient to entitle the Museum collection to rank among the finest in the world.

Previously to December, 1858, no part of this collection was exhibited to the general public. Two rooms however are now appropriated to the purpose, contiguous to the zoological collection, on the upper story. Only one of these, the "first room," is as yet completely fitted up. It comprises many interesting objects, especially "a trunk of *Alsophila Brunonia*, 45 feet in height, from the mountains of Sylhet; two trunks of *Alsophila contaminans*, from the Philippine Islands, with a section of the same from New Guinea; two lofty stems of the great New Zealand Fern Tree, *Cyathea Dealbata;* and another fine species from New Zealand, *Cyathea Medullaris;* the tree-fern of the Cape of Good Hope, *Hemitelia Capensis;* and several specimens of *Dicksonia Antarctica*, one of which is remarkable for the bifurcation of its stem, and another for the curious induration of its central pith." In the wall-cases are "specimens of remarkable Cryptogamic structures, chiefly Ferns, but including

also *Algæ* and *Fungi;*" also "specimens of Palms, including portions of stems and their sections, fronds, spathæ and spadices, and fruits." There is also exhibited a curious selection of specimens, chiefly fruits, preserved in spirit of wine or pyroligneous acid. "Cases 16, 17, and 18, which terminate the series of wall-cases, are devoted to a collection of clay models of English Fungi, made by the late Mr. James Sowerby, while engaged in the publication of his work on that tribe of plants, and representing for the most part the identical subjects depicted in it. The table-cases are chiefly occupied with sections of woods: some of these are what are called cabinet-woods, "including nearly all those which are more or less frequently employed by the London cabinet-makers, and arranged alphabetically, according to the names by which they are ordinarily known in the trade." Other divisions embrace sections of woods from particular countries, as Ceylon, New Holland, New Zealand, British Guiana, &c., arranged in alphabetical order, according to the native names, with the scientific names appended when known. Another division is that embracing "specimens illustrative of diseases, wounds, or other injuries of trees; of their reparation, either in whole or in part; of the results of incisions made through the bark into the wood," &c., &c.

The whole of the departments of the Museum have now been noticed. Those which are open to the general public are open every day in Easter, Whitsun, and Christmas weeks, and on Mondays, Wednesdays, and Fridays in every other week, except the first week of January, of May, and of September, during which the Museum is closed. The hour of opening is ten, of closing four, in November, December, January, and February; five in March and April, September and October; six in May, June, July, and August.

We shall now conclude with some notice of the official publications of the Museum. A synopsis or guide to the different collections appears to have been first issued by the establishment in 1808, and had gone through sixty-three editions by the year 1856. This was edited by the principal librarian, and the description of each department drawn up by its keeper. It is stated in a notice signed by Mr. Panizzi, of the date of January, 1859, that "a synopsis is in course of preparation, which will give a fuller description of the collections visited by the public, will be accompanied by scientific and literary notes, and illustrated by wood-engravings." There are now sold in the Museum a 'Guide to the Exhibition Rooms of the Departments of Natural History and Antiquities,' price 6*d.*, and other "Guides," one to the printed books, one to the autographs and manuscripts, and one to the drawings and prints exhibited in the show-cases, price one penny each.

Of a different description are the volumes which are intended for the use, not of visitors, but students. In the Printed Book Department there are, passing over the obsolete catalogue of 1787, the 'Alphabetical Catalogue of the Library of Printed Books,' by Sir H. Ellis and Rev. H. H. Baber, 7 vols. 8vo, 1813–19; and the 'Alphabetical Catalogue of the Printed Books,' by Mr. Panizzi, vol. i., folio, 1841, containing the letter A only. To these must be added the alphabetical catalogue of the King's Library by Sir F. Barnard, 'Bibliothecæ Regiæ Catalogus," 5 vols. folio, 1820–29, which was never made an article of sale, but copies of which have found their way to auctions, where they now sell for about 12*l.*, the 'Catalogue of the Geographical Collection, or Maps and Drawings in the Library of King George III.,' 1 vol. folio, or with the same types, 2 vols. 8vo, 1829; and the 'Bibliotheca Grenvilliana,' or catalogue of the Grenville Library, 2 parts in 3 vols. 8vo, 1842–48.

In the manuscript department, are, 'The Catalogue of the MSS. of the King's, or Royal Library,' by David Casley, the under-librarian, 1 vol. 4to, 1734, that of the 'Cottonian MSS.' by J. Planta (superseding a previous one by T. Smith), published by the Commissioners of Public Records, 1 vol. folio, 1802; that of the 'Harleian MSS,' by Humphrey Wanley and the Rev. R. Nares, with a classified index, by the Rev. T. H. Horne, also superseding a previous catalogue, and also published by the Commissioners of Public Records, 4 vols. folio, 1808; that of the MSS. heretofore undescribed, that is, the 'Sloane and Birch Manuscripts,' by the Rev. S. Ayscough, 2 vols. 4to, 1782; that of the Hargrave MSS., by Sir H. Ellis, 4to, 1818; that of the Lansdowne MSS., by F. Douce and Sir H. Ellis, folio, 1819; of the Arundel MSS., and of the Burney MSS. by Rev. J. Forshall, 2 parts forming 1 vol. folio, 1834–40. Instead of printing the catalogues of the additional MSS., after the conclusion of the Ayscough catalogue, they have hitherto been left in manuscript, and an index only has been printed; 'Index to additional MSS., acquired between 1783 and 1835,' by Rev. W. U. Richards and E. A. Bond, 1 vol. folio, 1849. From this time onward there are printed lists of additional manuscripts, one for 1836–40, and one for 1841–45, and written lists of the new acquisitions are prepared for the use of the public in a few months after their acquisition. A separate Oriental catalogue is in progress in the Latin language, 'Catalogus Codicum manuscriptorum Orientalium,' of which part 1, containing the Syriac and Carshunic manuscripts published in 1838, is by Dr. Rosen; part 2, containing the Arabic, commenced by the Rev. W. Cureton, is now being continued by Mr. F. Rieu, and part 3, containing the Ethiopic is by Dr. Dillman. There is also a catalogue of the manuscript music by Mr. T. Oliphant, 1 vol. 8vo, 1842, and a catalogue of the 'Manuscript Maps, Charts, and Plans, by Mr. J. Holmes, 2 vols. 1844. Part 1, of the 'Greek Papyri in the British Museum' was published by the Rev. J. Forshall in 1839.

In the department of antiquities a 'Description of the Ancient Terra Cottas,' by Mr. Taylor Combe, was published in 1810; and a 'Descriptio Nummorum Veterum,' by the same officer in 1814. He also commenced a 'Description of the Ancient Marbles in the British Museum,' a splendid series of folio volumes with copper-plates, of which ten have now appeared, the first bearing date 1810, and the last 1845. The circumstance that photographs are now taken from the sculptures, and sold by the Museum seems to announce that this undertaking will not be carried on on the same scale and plan, for in nothing does the artist so thoroughly fail in comparison with the sun as in delineating sculpture. The letter-press of the ten volumes comprises a description of the Townley marbles, and the miscellaneous collection of ancient marbles by Mr. Taylor Combe, in the first four volumes; of the room called the 'Columbarium' in the fifth, by Messrs. Combe and Hawkins; of the Parthenon, its metopes and frieze, by Mr. Hawkins, in the three following; and of miscellaneous sculptures, partly of the Townley collection, in the two last, by Messrs. Hawkins, Birch, and Newton.

The departments of Natural History were long unrepresented in the official publications of the Museum—of course, excepting the Synopsis—but the publications of that department are now more numerous than those of all the others. They consist in general of small closely printed volumes, of an unpretending appearance, and sold at moderate prices. One series, the 'List of British Animals,' extends to seventeen parts in small volumes; and from the list given in the 'Guide to the Exhibition Rooms' for 1859, there appear to be no less than fifty-two distinct works or sets of works, either published or in course of publication. The whole are under the editorship of Dr. J. E. Gray, who suggested their preparation.

The unofficial guide-books to the Museum are numerous. One entitled 'A View of the British Museum, or a regular Account relating what is most remarkable and curious to be seen there,' bears no date, but appears to have been issued soon after its opening, and they have grown more abundant of late years than ever. Much has been written on the subject of the Museum in periodical publications at different times. There are articles containing original information in vol. xv. of the 'North British Review,' and in the 'Edinburgh Review' for 1859. But it is certainly remarkable that of so important a building there is no detailed architectural description; and of so important an institution, no history that approaches to amplitude or completeness. The subject is one which abounds in interest of all kinds, but no one has taken it up. It would be impossible to do it justice in narrower limits than those of at least one octavo volume.

BROKEN WIND is a peculiar affection of the *wind* or breathing of the horse, in which the expiration of the air from the lungs, occupying double the time that the inspiration of it does, requires also two efforts rapidly succeeding to each other, and attended by a slight spasmodic action, in order fully to accomplish it. Examination of the animal after death has satisfactorily explained the reason of this. Some of the air-cells, particularly round the edges of the lungs, are ruptured; they have run into one another, and irregularly-formed cavities have thus been made, into which the air may easily enter but cannot without considerable difficulty be expelled. This disease may also be recognised by a characteristic low grunting cough, likewise easily explained by this morbid structure of the lungs.

If the usual breathing has been rendered thus laborious, it is evident that the horse, without skilful management, will be utterly incapable of rapid and continued exertion. In fact, if he is but a little hurried he evinces evident distress, and, if still urged on, he drops and dies; this, therefore, is one of the worst species of *unsoundness*.

The cause of the rupture of the air-cells may be previous inflammation of the lungs, by which a portion of them has been rendered impervious, and thus greater labour thrown on the remaining parts. The delicate structure of the cells, probably weakened by the inflammation in which it had shared, yields to the unnatural distension to which they are thus exposed. Many a horse has become broken-winded when urged to extra exertion immediately after he has been fed; for the air rushing violently into the lungs in the act of sudden and forcible inspiration, and the full stomach lying against the diaphragm, with which the body of the lungs is in contact, their perfect expansion is prevented, and those parts of them, the edges, which are free from this pressure, are unnaturally dilated and ruptured. The kind of food also to which the horse is accustomed has much to do with this disease If it is comparatively innutritive, a greater bulk of it must be eaten, and the distended stomach will oftener and longer press upon the diaphragm and impede the dilatation of the lungs, or render it unequal in different parts. Thus, broken-wind is a disease of the farmer's horse fed too much on hay or chaff; it is often produced in the straw-yard, where little more than the coarsest food is allowed; but it is comparatively seldom seen in the stable of the coach-proprietor, in which the food is of a better quality, and lies in a smaller compass, and is more regularly administered; and it never disgraces the hunting or racing stable. It must, however, be confessed, that there is sometimes an hereditary predisposition to this disease, consisting in a narrowness of chest, or a weakness of structure in the lungs.

There is no cure for broken-wind; no art can restore the dilated cells to their former dimensions, or build up again a wall between them. But palliative measures may be adopted to a very considerable extent. The food should be of a more nutritive kind, and lying in a smaller compass. Straw and chaff should be forbidden, the quantity of hay perhaps a little diminished, and that of corn correspondingly increased. A mash should constitute a part of the evening's fare; water should be sparingly given during the day, and exercise should not be required when the stomach is full. Occasional or periodical fits of greater difficulty of breathing should be met by small bleedings and gentle laxatives. By this management, not only will the broken-winded horse be rendered useful for many ordinary purposes, but will be capable of service and labour, which it would otherwise be cruel to require of him.

BROKER, a person who is employed on commission in negociating mercantile transactions between other parties, generally in the interest of one of the principals, either the buyer or the seller, but who sometimes acts as the agent of both. As it usually happens that individual brokers apply themselves to negociations for the purchase and sale of some particular article or class of articles, they by that means acquire an intimate knowledge of the qualities and market value of the goods in which they deal, and obtain an acquaintance with the sellers and buyers as well as with the state of supply and demand, and are thus enabled to bring the dealers together and to negociate between them on terms favourable for both. A merchant who trades in a great variety of goods and products drawn from different countries, and destined for the use of different classes, cannot have the same intimate knowledge for his guidance, and will consequently find it advantageous to employ several brokers to assist him in making his purchases and sales.

Ship-brokers form an important class in all great mercantile ports. It is their business to procure goods on freight or a charter for ships outward bound; to enter and clear vessels at the Custom House; to collect the freight on the goods which vessels bring into the port, and generally to take an active part in the management of all business matters occurring between the owners of the vessels and the merchants, whether shippers or consignees of the goods which they carry. In the principal ports of this kingdom almost all ship-brokers act also as *insurance-brokers*, in which latter capacity they procure the names of underwriters to policies of insurance, settling with the latter the rate of premium and the various conditions under which they engage to take the risk, and receiving from them the amount of their respective subscriptions in the event of loss. When such loss is partial, it becomes the duty of the broker to arrange the proportions to be recovered from the underwriters. The business of an insurance-broker differs from that of other brokers in one particular. The latter, when they give up the name of the party for whom they act, incur no responsibility as to the fulfilment of the conditions of the contract, while an insurance-broker is in all cases personally liable to the underwriters for the amount of the premiums. But he does not incur any liability to make good the amount insured, to the owner of the ship or goods, who must look to the underwriter alone for indemnification in case of loss. Under these circumstances, it is the duty of the insurance-broker to make a prudent selection of underwriters. Merchants frequently act as insurance-brokers.

Exchange-brokers negociate the purchase and sale of bills of exchange drawn upon foreign countries, for which business they should have a knowledge of the actual rates of exchange current between their own and every other country, and should keep themselves acquainted with circumstances by which those rates are liable to be raised or depressed; and they should besides acquire such a general knowledge of the transactions and credit of the merchants whose bills they buy, as may serve to keep their employers from incurring undue risks. Persons of this class are sometimes called bill-brokers, a title which is likewise given to another class of brokers, whose business it is to employ the spare money of bankers and capitalists in discounting bills of exchange which have some time to run before they will become due.

The business of a *stock-broker* is that of buying and selling, for the account of others, stock in the public funds, and shares in the capitals of joint-stock companies. The acts of parliament by which the proceedings of stock-brokers are in certain cases regulated are the 7 Geo. II. cap. 8, and 10 Geo. II. cap. 8; and under these, every bargain or contract for the purchase and sale of stock which is not made *bonâ fide* for that purpose, but is entered into as a speculation upon the fluctuations of the market, is declared void; and all parties engaged in the same are liable to a penalty of 500*l.* for each transaction.

Every person desirous of acting as a broker for the purchase and sale of goods within the city of London must be licensed for that purpose by the lord mayor and court of aldermen. When admitted, the broker must give bond, conditioned with a penalty of 500*l.*, for the faithful discharge of his duties, without fraud or collusion, and to the utmost of his skill and knowledge. He is sworn to this effect, and further binds himself not to deal in goods upon his own account—a stipulation which is very commonly broken. It is the indispensable duty of a broker to keep a book in which all the contracts which he makes must be entered; and this book may be called for and received as evidence of transactions when questioned in courts of law. Each broker pays on admission a fee of 5*l.*, and an equal sum annually so long as he continues to act under his licence: any person acting as

broker without having procured a licence or paid the fees, is liable to a fine of 100*l.* for every bargain which he may negociate.

It is usual to apply the name of broker to persons who buy and sell second-hand household furniture, although such an occupation does not bear any analogy to brokerage as here described, furniture dealers buying and selling generally on their own account and not as agents for others. These persons do indeed sometimes superadd to their business the appraising of goods and the sale of them by public auction under warrants of distress for rent, for the performance of which functions they must provide themselves with an excise licence, and also conform to the regulations of the 57 Geo. III. c. 93.

The business of a pawnbroker is altogether different from that of the commercial brokers here described. [PAWNBROKER.]

BROMAL. [OTHYL, COMPOUNDS OF.]

BROMANILINE. [ANILINE.]

BROMEIN ($C_{20}H_6Br_4$?). A crystalline substance, little known, obtained by acting with bromine upon crude hydride of phenyl.

BROMETHIONESSIL ($C_{52}H_{14}Br_4S_2$?). An unimportant derivative of hydride of benzoyl.

BROMIC ACID. [BROMINE.]

BROMIDES. [BROMINE.]

BROMINE (Br). An elementary fluid body, discovered, in 1826, by M. Balard, a distinguished French chemist. The name of this substance is given to it from *βρῶμος* (brōmos), a stink or strong smell, on account of its powerful and disagreeable odour: it was first procured by its discoverer from the mother water or bittern remaining after the crystallisation of common salt at the salt-works of Montpellier. It was soon afterwards found in sea-water in the state of bromide of magnesium, and has since been met with in various salt-springs, and especially those of Germany. At Theodorshalle, near Kreutznach, it is found in sufficient quantity to be extracted with advantage, 100 avoirdupois pounds of the water yielding 2 ounces and 80 grains of bromine. Dr. Daubeny has detected bromine in several mineral springs in England, and he states that it occurs in most of those that yield much common salt, except that of Droitwich in Worcestershire. Balard has also found that it exists in marine plants growing on the shores of the Mediterranean, in the ashes of sea-weeds that furnish iodine, and in those of some animals, especially of the *Ianthina violacea*, one of the testaceous mollusca.

Balard obtained bromine by the following process: Into a bottle two-thirds filled with bittern he passed a current of chlorine gas; this decomposed the salt of bromine contained in it, and set the bromine at liberty. He then filled the bottle with sulphuric ether, which dissolved the bromine, and became of a fine hyacinthine-red colour; this was decanted and shaken with a solution of potash, which combined with the bromine; the solution of bromide of potassium thus obtained yielded by evaporation cubic crystals of the salt; these were powdered and mixed with peroxide of manganese and sulphuric acid diluted with half its weight of water; the bromine evolved by this process was received in a vessel of cold water which condensed it. More economical processes have since been adopted, but this is sufficient to explain the principle.

Bromine has the following properties: It is liquid at the usual temperature of the air. Its specific gravity is 2·966. It is poisonous. In considerable bulk, its colour is a deep brownish red; in small quantities, it is of a hyacinthine red. Its odour is extremely strong, greatly resembling that of chlorine: its taste is disagreeable. When exposed to a temperature of 9·5° Fahr., it becomes solid, crystalline, brittle, and hard enough to be powdered. It boils at about 145·4° Fahr., and its volatility is great, for at common temperatures it emits a red vapour resembling that of nitrous acid. The density of this vapour is about 5·340, and 100 cubic inches weigh about 167·4 grains.

Bromine suffers no change by the agency of light, heat, or electricity, and having never been decomposed, it is regarded as an elementary or simple substance. In the decomposition of its compounds by electricity, it is evolved at the positive pole, and consequently resembles in this respect oxygen, chlorine, and iodine, and is like them also in being when vapourised, a powerful supporter of combustion, some substances burning in it as in chlorine gas: its vapour extinguishes a taper; it is soluble in water and alcohol, and especially in ether; it resembles chlorine in destroying vegetable colours. It is very corrosive and poisonous, acting upon and destroying organic matter with great energy. It renders a solution of starch yellow. Its equivalent number is 79·97.

Oxygen and bromine form only one compound, which is

Bromic acid (BrO_5). These elements do not combine directly, but only when exposed to each other in their nascent state. When, for example, bromine is combined with potash, there are formed bromate of potash and bromide of potassium; and when in the same way there are formed bromate of baryta, and bromide of barium, the bromate treated with sulphuric acid yields bromic acid and sulphate of baryta; and the aqueous solution of the acid being slowly evaporated is converted into a fluid cf the consistence of a syrup: if the evaporation is carried farther, one part of the acid is volatilised, and another decomposed into bromine and oxygen.

Bromic acid has a scarcely sensible smell. It taste is sharp, but not caustic. It first reddens, and then destroys, the colour of litmus paper. Sulphurous and phosphorous acids and the hydracids decompose bromic acid, and set the bromine free. Sulphuric acid also partly decomposes it into oxygen and bromine, because it absorbs the water. Bromic acid is composed of—

Five equivalents of oxygen . .	8 × 5 = 40
One equivalent of bromine . . .	79·97
Equivalent . .	119·97

Nitrogen and Bromine. These elements unite to form a detonating oily liquid resembling chloride of nitrogen. Its composition is not known.

Hydrogen and Bromine combine to form

Hydrobromic acid (HBr). This compound is obtained with difficulty by direct action, but at a high temperature these elements slowly unite. Hydrobromic acid may be procured by distilling bromide of potassium with concentrated sulphuric acid; the product is mixed however with bromine and sulphurous acid, because the hydrogen of the hydrobromic acid decomposes a portion of the sulphuric acid. The best method is to mix bromine and phosphorus and a little water; there is produced by their action bromide, or perbromide of phosphorus, which decomposes water, and evolves hydrobromic acid gas, which may be procured in the gaseous state over mercury, or dissolved in water.

Hydrobromic acid may also be abundantly procured by decomposing bromide of potassium with a concentrated solution of phosphoric acid.

Hydrobromic acid gas is colourless, and forms a thick vapour on coming into the air. Its smell resembles that of hydrochloric acid; its specific gravity, according to Berzelius, is 2·731; 100 cubic inches consequently weigh 84·72 grains. It acts upon the metals and their oxides precisely in the same way as hydrochloric acid gas. It is not altered by being passed through a red hot tube, either alone or mixed with oxygen gas. Chlorine separates the bromine from it, and hydrochloric acid is formed. Hydrobromic acid gas is very soluble in water, and the solution has a greater specific gravity than liquid hydrochloric acid; it is colourless, strongly acid, and suffers no change by exposure to the air. Nitric acid decomposes it, and an *aqua regia* is formed, which dissolves gold and platinum.

Hydrobromic acid is composed of—

One equivalent of	hydrogen	= 1
One „	bromine	= 79·97
Equivalent . .		80·97

When it is decomposed by potassium, hydrogen gas, equal to half the volume of the acid submitted to experiment, remains, and bromide of potassium is formed.

Chlorine and Bromine form chloride of bromine. It is prepared by passing a current of chlorine gas over bromine, and condensing the vapour arising, by a freezing mixture. It is liquid, has a reddish-yellow colour, lighter than that of bromine. It has a strong, unpleasant smell, and its taste is extremely disagreeable. It is volatile, and soluble in water: the solution possesses bleaching power. It does not possess acid properties, but when mixed with the alkalies forms chlorides and bromides. It has not yet been analysed.

Sulphur and Bromine.—These substances combine readily by mere mixture; the resulting bromide is fluid, has an oily appearance and reddish tint. It emits white vapours when exposed to the air. When moist it reddens litmus paper strongly, but slightly when dry. Boiling water is decomposed by bromide of sulphur, and there are produced hydrobromic, hydrosulphuric, and sulphuric acids. Its composition is unknown.

Phosphorus and bromine combine readily to form two compounds; the terbromide is liquid, and the perbromide is solid. The terbromide (PBr_3) is composed of three equivalents of bromine 239·91, and one of phosphorus 32·02 = 271·93. Both bromides are prepared by mixing these elements in a flask containing carbonic acid gas: action takes place, with evolution of light and heat, and there are formed the solid perbromide which sublimes in the upper part of the flask, while the fluid terbromide remains in the lower part.

The perbromide (PBr_5) is of a yellow colour; by heat it becomes red. It decomposes water, and there are formed hydrobromic and phosphoric acids.

Bromine and iodine form probably two bromides of iodine; the protobromide, or that so considered, is a solid compound, which is by heat convertible into a reddish-brown vapour, condensing into small crystals of the same colour, resembling fern leaves in appearance.

When bromine is added to the above described crystals a liquid is formed, which unites with water and gives a solution possessing bleaching power. It is probably the perbromide of iodine.

We have now mentioned the principal binary compounds of bromine, except those which contain a metal: for these as well as for an account of the bromates which their oxides form with bromic acid, we refer to each particular metal.

Bromine and its compounds are employed in photography, they are also much used in organic chemical research, and the bromide of potassium has been employed in medicine.

BROMIODOFORM (C_2HBr_2I). This compound is obtained by treating iodoform with bromine. It is a colourless liquid, which solidifies at 32° to a white mass like camphor. It posesses a penetrating odour, and a saccharine taste.

BROMOBENZOIC ACID. [BENZOIC ACID.]

BROMOBRUCINE. [NUX VOMICA, ALKALOIDS OF.]

BROMOCINCHONINE. [CINCHONA, ALKALOIDS OF; CINCHONINE.]

BROMOFORM (C_2HBr_3). This compound is obtained by distilling a mixture of bromide of lime with alcohol and water. It is a heavy liquid, its specific gravity being 2·10. It is volatile. By potash it is converted into bromide of potassium and formate of potash.

BROMOSALICYLIC ACID. [SALICYLIC ACID.]

BRONAPHTASE ($C_{20}H_7Br$) is one of the numerous compounds obtained from naphthaline. It is formed by the direct action of bromine on naphthaline, care being taken not to add the bromine in excess, which would produce *bronaphtese*. Bronaphtase is a colourless oil, decomposed by chlorine and bromine.

BRONAPHTESE ($C_{20}H_6Br_2$) is formed by the action of bromine on naphthaline, or on *bronaphtase*. It is a crystallisable solid, and forms several compounds with bromine.

BRONAPHTISE ($C_{20}H_5Br_3$) is obtained by heating the bromide of *bronaphtese*.

BRONAPHTOSE ($C_{20}H_4Br_4$), a compound with this formula, has been obtained in two forms, both crystallisable.

BRONCHITIS, inflammation of the bronchi, that is, the tubes which convey air to the lungs. The respiratory organs consist of the windpipe, or the air-tube; of clusters of minute bags called air-cells, which constitute the proper substance of the lungs, and of a delicate but firm membrane which encloses the lungs, as in a sheath, termed the pleura. Each of these component parts of the respiratory apparatus is subject to its own peculiar diseases. Hence the diseases of the respiratory organs are arranged into three classes: first, into those which affect the air-tube; secondly, into those which affect the proper substance of the lung [PNEUMONIA]; and, thirdly, into those which affect its investing membrane, the pleura. [PLEURITIS.]

The air-tube or windpipe is divided into several portions. Each of these portions possesses a peculiar structure, and performs a specific function. Of these divisions the first is termed the larynx, which constitutes the principal organ of the voice, and is situated at the upper part of the neck. Immediately continuous with the larynx is a large tube called the trachea, situated at the fore part of the neck. Opposite the third vertebra of the back the trachea divides into two great branches, named the bronchi, one branch for each lung; the right bronchus going to the right lung, and left bronchus to the left lung.

Each of the bronchi at the place where it enters the lung, subdivides into several branches which penetrate the substance of the lung, where they again divide, subdivide, and spread out after the manner of the branching of a tree. Successively diminishing in size as they subdivide, the bronchi at length form an infinite number of minute tubes, which at their ultimate terminations dilate into the little bags termed the air-cells of the lungs. The larynx, the trachea, the bronchi and their ramifications, together with the cavities of the nose, the mouth, and the pharynx, are all classed together under the common name of the air-passages. All these parts are lined by a membrane, which from the nature of its secretion is termed mucous membrane. In every part of the body the mucous membrane possesses the same essential structure, and is subject to analogous diseases. Accordingly, although the structure of the mucous membrane of the air-passages is somewhat modified in the nose, in the fauces, in the larynx, in the trachea, in the bronchi, and in the air-cells, according to the different functions which it has to perform in these different organs, yet as it possesses in its whole extent the same essential organic characters, so the diseases to which it is subject are perfectly similar. All these diseases may be included under congestion, inflammation, hæmorrhage (effusion of blood from its surface), emphysema (the dilation of the tubes), and polypi (concretions growing from its surface, which obstruct and sometimes nearly obliterate the tubes).

Of these diseases inflammation is by far the most common and the most important. Inflammation of the mucous membrane of the air-passages, is divided into species, according to the nature of the secretion in which the inflammatory action terminates. Thus the inflammation may terminate in a secretion which does not concrete after its formation; this is termed *catarrhal* inflammation. It may terminate in a secretion which instantly concretes as it is formed; this is called *plastic* inflammation or croup: or it may terminate in the destruction of the mucous membrane and the formation of ulcers; this is termed *ulcerous* inflammation.

Catarrhal inflammation, or that in which the inflammatory action produces a secretion which does not concrete, is again subdivided principally according to the colour and consistence of the matter secreted. If the secretion be of a yellow colour, and not tenacious, the disease is called *mucous catarrh;* if the secretion be transparent and viscous, the disease is termed *pituitous catarrh.* When the inflammation is confined, as it often is, to that portion of the membrane which lines the nose, it constitutes the disease commonly known under the name of *cold* or *catarrh,* the technical name of which is *coryza.* When the inflammation extends to the mucous membrane which lines the

fauces, tonsils, and pharynx, the disease is called *cynanche tonsillaris* and *pharyngea.* When the inflammation is seated in that portion of the mucous membrane which lines the larynx, the disease is called *laryngitis;* and when it affects the mucous membrane of the bronchial tubes and their ramifications, it constitutes the disease termed *bronchitis.*

While a common function is performed by the air-passage from its commencement at the mouth and nostrils to its termination in the air-cells, namely, the transmission of air to and from the lungs, additional and very different functions are performed by the several portions of this extended tube. Accordingly inflammation of the membrane that lines it produces widely different effects, according to the portion of the membrane in which the disease is seated; giving rise to the distinct forms of disease just enumerated. The description of these several diseases is given under their respective names; the disease named bronchitis is that at present to be treated of.

Medical writers distinguish between what they term the state of congestion and that of inflammation. In congestion the blood-vessels are merely loaded with a preternatural quantity of blood; in inflammation the blood-vessels, besides being loaded with a preternatural quantity of blood, are in a state of diseased action, which, without any precise knowledge having been acquired of the nature of that action, is termed inflammatory. Simple congestion of the mucous membrane of the bronchi is a frequent affection, which may be induced by any cause that impedes the return of the blood to the left side of the heart. If suddenly and intensely produced, which sometimes though rarely happens, it may prove fatal with all the symptoms of asphyxia [ASPHYXIA]. Several cases are on record in which persons were seized suddenly, without any apparent cause, with extreme difficulty of breathing, which progressively increased until it terminated in death; and on the examination of the body, no morbid appearance could be detected, excepting a general congestion of blood in the capillary vessels of the mucous membrane, of the bronchi and its ramifications. In a slighter form, congestion of the mucous membrane of the bronchi is a constant attendant on various diseases, more especially fever of every type, whether common continued fever, or typhus, or scarlet fever, or measles, or small-pox. In the state of congestion the mucous membrane is preternaturally red, the tinge of colour varying according to the intensity of the affection from a pale to a brownish or purplish red.

When the mucous membrane of the bronchi is in a state of active inflammation, it is of a bright red or crimson colour. This inflammatory redness may be partial or general; but it more commonly affects particular parts of the membrane than its entire surface. Sometimes the redness is confined to the larger bronchial tubes, or it may be limited to the smaller. Sometimes it exists in the bronchus of one side only; at other times it equally affects both bronchi.

Two consequences result from the congestion and inflammation of the membrane: first, the swelling and thickening of the membrane, in proportion to which must of course be an obstruction to the passage of the air; and, secondly, an increase in the quantity of its mucous secretion. This increase and change in the secretion are chiefly the result of inflammation, in some cases of which affection the secretion becomes so excessive as completely to fill up the bronchial tubes, and thereby to occasion suffocation.

The trachea and the bronchial tubes being mere conduits of air, the disturbance of function produced by the inflammation of this portion of the air-passage must of course relate chiefly to impeded transmission of the air. Accordingly difficulty of breathing is the most prominent symptom of inflammation seated in this portion of the air-tube. This difficulty of breathing is proportionate to the obstruction to the passage of the air, which is proportionate to the degree of the swelling of the membrane, and to the extent of membrane involved in the inflammatory affection. If the inflammation be limited to a portion only of a single tube, the difficulty of breathing will not be great; if it affect the whole tubes of one side, the difficulty of breathing will be considerable; if it affect all the tubes of both lungs, the difficulty of breathing may be so great as to prove fatal. Together with impeded respiration, there is a feeling of tightness and oppression across the chest, accompanied with a sense of heat, sometimes amounting to a burning sensation, often referred by the patient to the sternum. Cough is always present. The cough at first is dry, because the membrane is dry; but the secretion soon becomes more abundant than natural. The matter first secreted is acrid; and this acridness diminishes as the quantity of the secretion increases; and when the matter secreted assumes a yellow colour, it is always quite bland; and then the cough is loose and the expectoration free.

When the inflammation is seated in the mucous membrane that lines the cavities of the nose and pharynx, the morbid changes which the membrane undergoes during this process are in some degree manifest to the eye. It is obvious that the part affected becomes redder than natural; that its blood-vessels appear larger, more numerous, and more turgid with blood; at the same time the membrane swells and becomes thicker and firmer than natural. At first it is perfectly dry; for the first effect of the state of inflammation is the suppression of secretion: but soon a transparent thin and acrid fluid is poured out by the inflamed vessels, which irritates and even excoriates all the parts with which it comes in contact. After flowing for a certain time, varying from a few hours to two or three days, according to the intensity of the disease, this morbid

secretion changes its character, loses its acrid nature and becomes more bland, but still remains transparent. In an indefinite time, in general in two or three days, still further changes take place ; its bland character remains, but its colour is altered ; it gradually assumes a greenish tint ; it then passes to yellow, and finally becomes of a bright brimstone hue. As the disease proceeds the condition of the membrane is changed ; for as the bland fluid is formed the morbid thickness and firmness of the membrane diminishes, and it gradually returns to its healthy condition.

The redness, swelling, and firmness of the membrane, together with its altered secretions, are then local signs visible to the eye which denote the inflammatory condition of the membrane in coryza and in cynanche tonsillaris and pharyngea. The membrane being in part manifest to our senses in the situations in which these diseases have their seat, we can observe the morbid process that goes on, and mark its different stages. It is probable that a perfectly analogous process goes on when portions of this membrane which are placed beyond our view are inflamed. When the inflammation is seated in the larynx the membrane cannot be seen. That the particular portion of the membrane which lines the larynx is in a state of inflammation is a matter of inference derived from the disturbance of the function of the organ, namely, the function which relates to the formation of the voice. But when inflammation descends further into the trachea, the bronchial tubes and their ramifications, not only are we altogether unable to see the condition of the membrane, but as the functions of those tubes are so simplified as to be mere conduits of air, the only indication we can obtain that they are in a state of disease must arise from the disturbance of that single function, namely, difficulty of breathing. Certainly there will be combined two other symptoms, namely, cough and expectoration ; but these are common to various other diseases of the lungs, and consequently cannot be diagnostic, that is, distinctive : while difficulty of breathing is common to every disease of the lungs and heart which has arrived at a certain degree of intensity. When inflammation is seated in these distant portions of the mucous membrane of the air passages, it is impossible to arrive at any certain knowledge of the specific disease from the symptoms or the signs of disordered function only.

It has been shown that inflammation of the mucous membrane of the air-passages has two consequences, first, a swelling of the membrane, and secondly, a change of its secretions ; the local signs by which the inflammation of the bronchi and of their ramifications is ascertained and discriminated from all other diseases, have reference to these two conditions.

When the inflammation of the mucous membrane of the bronchial tubes is considerable, the swelling of the membrane may be so great as completely to close that portion of the tube in which the inflammation is seated. The consequence must be that the respiratory murmur [AUSCULTATION] cannot be heard in that portion of the lung which the tube supplies, since no air can pass the obstructed point ; accordingly, on applying the ear, or the stethoscope [STETHOSCOPE] to the chest it is found, especially in severe affections of this kind, that the respiratory murmur is absent in various portions of the lungs. This absence of the respiratory murmur is however common to several other affections of the lungs. Hence percussion must be called to the aid of auscultation. By striking the chest [PERCUSSION] it is found that the sound elicited is natural in bronchitis, while in almost every other affection of the lungs it is dull where there is no respiratory murmur. The reason of this difference is, that in bronchitis the cells are filled with air, so that a natural sound is elicited by percussion ; but the obstruction occasioned by the swelling of the inflamed membrane confines and prevents the renewal of the air, and consequently the respiratory murmur is lost ; while in other affections attended by absence of the respiratory murmur the air-cells are impermeable, either from their consolidation or compression, and then the sound, on percussion, is invariably dull and fleshy. If on the other hand the inflamed membrane be not so much swollen as completely to close the tube, then another and a totally distinct sound is produced—a whistling sound, a sound always observed to accompany an indistinct respiratory murmur, on account of the diminished calibre of the bronchial tube.

Moreover, when the swelling of the membrane diminishes, the nature of the sound is again entirely changed. It now becomes a loud, deep, and sonorous wheezing, the intensity of which is sufficient to cause a vibration upon the parietes of the chest, distinguishable by the hand ; at the same time the respiratory murmur becomes more distinct, denoting that the bronchial tubes are more open ; finally, the deep sonorous wheeze assumes a still deeper bass, merges into the respiratory murmur, mixes with it, and gives it a roughness which is termed *rough respiration*.

On the other hand, where the secretion re-appears and is in excess, a wheezing sound is produced, which is loud and noisy in proportion to the quantity of fluid poured into the tubes. This sound, when it is formed in the trachea, can be heard through the medium of the air alone ; but the application of the stethoscope, or the ear, to the surface of the chest is necessary when it is formed in the bronchial tubes.

Besides these local signs or symptoms derived from the altered condition of the immediate seat of the disease, there are others derived from the disturbance of the system in general. These general or feverish symptoms are lassitude, indisposition to motion, chilliness, often amounting to shivering, pains in the limbs, and more especially in the back and loins ; dullness and heaviness of the mind, or inability to carry on the intellectual operations with the usual vigour. The pulse is rapid and weak, and the urine scanty and limpid. These symptoms are soon followed by irregular flushes of heat, sometimes occurring at one part of the body, sometimes at another, alternating with the cold and intermingling with it, so that the patient feels frequently, in consequence of the rapidity of these changes, the two different sensations in the same place and almost at the same instant. The skin at length becomes universally hot, and commonly dry ; headache comes on ; there is more or less thirst ; the pulse continues rapid, but becomes full ; and the urine, which is still small in quantity, is now high-coloured. Then perspiration succeeding to the dry condition of the skin, the functions are again restored in a greater or less degree to their natural condition, and there is a corresponding remission of the symptoms. After this remission there is commonly an accession of the febrile attack, usually in the evening.

The causes which predispose to this disease are whatever causes diminish the general vigour of the system, such as great fatigue, excess of every kind, long exposure to a humid atmosphere, and so on. The great exciting cause is cold, especially when combined with moisture.

With regard to the treatment—when the disease is in its mild form nothing is required but confinement to the house in a uniform temperature in a warm room ; demulcent and diaphoretic medicines to determine to the surface ; mild aperients, and the abstinence from all stimulating food and drink. When the feverish symptoms have subsided, when all uneasiness of the chest is gone, and the cough is slight, some light tonic, as any of the ordinary bitters, will assist in restoring the strength of the patient, and in preventing a relapse.

When the disease is in its severer form, and dyspnœa, from an overloaded heart, is present, blood-letting is indispensable. The quantity of blood taken must of course be in proportion to the intensity of the disease and the strength of the patient, but it must be in sufficient quantity to relieve the heart. Antimonials exhibited in decided doses immediately after the blood-letting, commonly prevent the necessity of any further depletion. The best preparation of antimony is the tartar emetic, given in solution, to the extent of from a quarter to one grain every second or third hour. The vomiting induced by the first doses commonly subsides or becomes slight after the third or fourth dose. Occasionally, however, this remedy produces so much irritation in the stomach and the system in general that it cannot be given in the quantity necessary to render it efficient ; then ipecacuanha forms an excellent substitute, the powder of which may be given in doses of from one to two grains every three or four hours. When the fever subsides, the difficulty of breathing and oppression at the chest continue, blisters are highly advantageous. The cough, in itself teasing and exhausting, and often aggravating every other symptom, must be allayed by oily emulsions, barley water, linseed tea, &c. ; and if these fail, and the cough continue so violent as to prevent rest, opium must be given to the extent necessary to subdue it. The opium should always be combined with diaphoretics, so as to determine to the skin, the same time that irritation is allayed. The bowels should be kept moderately open during the whole course of the disease ; and there is no remedial measure of greater importance than the maintenance of the apartment steadily and invariably, day and night, at the same point, a point which will insure a moderate degree of warmth, from 65° to 70°. A great degree of heat is a most pernicious stimulus ; cold is the great exciting cause of the disease, and any considerable alternation from heat to cold, or from cold to heat, is of itself sufficient to counteract the beneficial operation of the most efficient remedies the most skilfully combined.

(Läennec on *Diseases of the Chest ; Lectures on the Diseases of the Lungs*, &c,, by Dr. T. Davies ; Art. *Bronchitis ;* Dr. Copeland's *Dict. of Pract. Med. ;* Watson's *Lectures on the Practice of Physic.*)

BRONCHI'TIS IN ANIMALS, or inflammation of the *bronchi* or air-tubes of the lungs, is a very serious disease among quadrupeds. It is occasionally confined to the lining mucous membranes of these passages, but it more frequently spreads to the lining membrane of the windpipe and larynx, and to a greater or less degree involves the substance of the lungs.

Horses.—It is not a common disease in the horse, but it is easily recognised by an interrupted wheezing sound in the breathing that can be heard at some distance ; a tendency to coldness in the extremities, distinct from the somewhat increased heat of catarrh and the deathy iciness of inflamed lungs ; a pulse quicker than either in catarrh or the early stage of pneumonia, not so hard as in pleurisy, but more so than in catarrh or inflamed lungs ; the nostrils dilated, and the respiration strangely quickened, being often more rapid than the pulse ; a haggard countenance ; an almost perfect inability to move, from fear of suffocation ; a cough exceedingly painful ; a purulent discharge from the nostrils of a grayish-green colour, which soon becomes fetid or mingled with blood ; the breath hot ; and no expression of pain in any particular part indicated by looking at the side or flank. Pieces of hardened mucus, or organised membrane, are also frequently coughed up.

Bronchitis is sometimes a primary disease, but it is oftener the consequence of a neglected catarrh or long-continued but slight inflammation of the lungs. It is occasionally epidemic. Every affection

of the respiratory organs will then rapidly degenerate into this disease. As it pursues its course, the membrane becomes thickened by inflammation, and the calibre of the bronchial tubes is proportionally diminished, while the mucous secretion is abundantly increased, and consequently the animal dies of suffocation, the air passages becoming completely clogged.

Bleeding should be early resorted to, but very cautiously; for what is true of every mucous membrane is more especially so here—the patient will not bear considerable or rapid depletion. While the blood is flowing, the finger of the veterinary surgeon should be on the submaxillary artery, and the vein should be pinned up as soon as the pulse begins to falter: four pounds will scarcely be withdrawn before this will be the case. *Physic* should also be administered, but very cautiously; for the sympathy between the mucous membranes is sooner developed in this case than in any other disease, and a degree of purging is readily excited which bids defiance to all control. Two drachms of aloes should be administered morning and night, until the fæces become softened. The dung having been rendered pultaceous, powdered digitalis, nitre, and sulphur should be administered morning and night, in doses varying according to the circumstances of the case. From half a drachm to two drachms of the first may be given, and from two to four drachms of each of the other drugs.

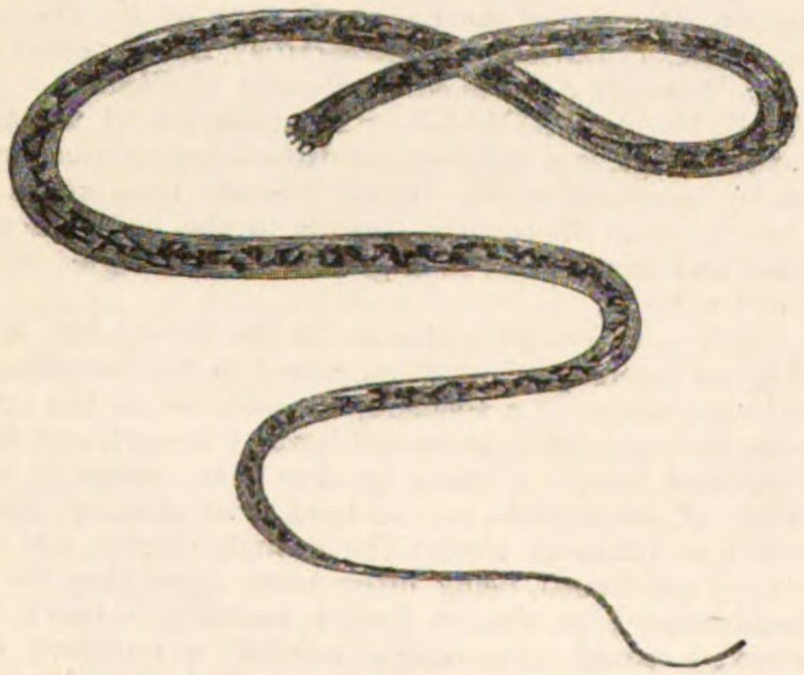
A blister is indispensable, and it should cover the brisket and sides, and extend up the windpipe even to the throat. The horse should not be coaxed to eat, and nothing more nutritive than mashes should be allowed.

Cattle.—Bronchitis is a still more formidable disease among cattle, and many thousand animals are yearly destroyed by it. The winter cough, which shameful neglect at first produces, and which inexcusable inattention and idleness suffer to continue, almost inevitably terminates in bronchitis or inflammation of the lungs, or both united. The food of cattle is much concerned in the production of it. Mouldy hay and bad straw, the very refuse of the farm, and the common aliment of the yearling cattle, too generally and fatally produce inflammation of the air-passages; and many a beast comes from the straw-yard bearing the seeds of death within him.

The most frequent victims of this disease however are young cattle, yearlings, and especially in low marshy or woody countries. On an upland farm, and particularly on a chalky and loamy soil, it is comparatively seldom known. It oftenest prevails in dry seasons, when the water of the brook fails, and that of the ponds is putrid and filled with animalculæ.

The attack of bronchitis is somewhat sudden; the animal has a dry, husky, and peculiarly distressing cough, and very soon begins to droop and to lose condition. It is painful to see the poor beast standing with his extended head, dilated nostrils, and anxious countenance; violently coughing, almost without intermission, until he is completely exhausted, and falls or dies of suffocation. This state of misery continues from a fortnight to a month. On examination after death, the bronchial tubes exhibit some inflammation, yet far less than could be expected; while, characterising the disease, and fully accounting for all its distressing symptoms, these passages and the wind-pipe, and often the larynx and the fauces, are filled with small worms, forming a kind of coat mixed with the mucus, or connected together in knots of various sizes. The disease is either produced or much aggravated by the presence of these worms and the irritation which they produce.

These worms belong to the Nematoid group, and have been named *Filaria bronchialis* and *Strongylus lævigatus*. They are of a thread-like form, from half an inch to two inches in length; the body round, the head obtuse, the mouth circular, and surrounded with minute barbs, or elongated papillæ; the tail of the female pointed, and that of the



male somewhat rounded and oblique. The female usually contains a great number of eggs; and a few of the ova, but so few as to appear to have been deposited there accidentally, are occasionally found enveloped in the mucus of the windpipe and the air-passages of the lungs. Of the natural history of this worm nothing is known, but the fact of the impregnation of the female shows that this is the last if not the only state of its existence.

The ova, or the minute worms, are received from the pastures, or, more probably, from the water, when stagnant or loaded with animalculæ. Being alive, it is probable they escape the digestive powers of the stomach, and mingle with the blood, and thread the various circulatory passages until they arrive at a congenial abode; or the ova may be hatched by the warmth and moisture of the mouth, and then wind their way to their destined residence.

The modes of cure are evident: we should either destroy or remove these intruders, or strengthen the animal so that he shall bear up against the irritation which they excite; for it is well known to the farmer that if the patients, by the natural power of their constitution, or by the application of certain means, can struggle with the disease until the cold weather sets in, and the worm dies, or must find another residence, they will eventually recover. The pasture should be changed as soon as the disease is discovered. The supply of fresh recruits will be prevented, or possibly that deleterious matter, whether connected with the water or the pasture, which is necessary to their thriving and multiplying, will be no longer obtained. The simple change of pasture in an early stage of the disease has saved thousands of young cattle.

If however these parasites have so far established themselves as to resist this mode of attack, it must be considered whether some agent cannot be brought into actual contact with them, which will either destroy them, or so far annoy and weaken them that they will loosen their hold and be expelled by the convulsive coughing of the calf. The most obvious method of accomplishing this is, to cause the patient to breathe some pungent and deleterious gas, such as that produced by the burning of sulphur or the evolution of chlorine. By both of these fumigations the worms have been quickly and perfectly destroyed, but there is considerable care required in the management of these experiments; inflammation in the air-passages, very difficult afterwards to allay, has been produced, and occasionally the beast as well as the worm has been destroyed. This mode of treatment should therefore be considered as a last resource, and should never be intrusted to inexperienced hands.

Common salt readily destroys many species of worms, and is conveyed through the circulatory vessels in a sufficiently pure state to expel these vermin from the air-passages: at the same time it is an admirable tonic, and supports the decaying strength of the animal. The most powerful vermifuge however in these cases is lime-water, and if half a pint of it, with a couple of ounces of common salt, is given to each patient every morning, attention being paid to a change, and perhaps a repeated change of pasture, and to the comfort of the animals in other respects, the majority of them will be saved.

This disease occasionally appears in lambs, deer, and swine. The mode of treatment should be the same as for calves.

BRO'NCHOCELE (*βρογχοκήλη*), from *Βρόγχος* (bronchos), *throat*, and *κήλη* (cēle), a *swelling*; called also Goître and Derbyshire Neck; a swelling in the upper and fore part of the neck, occasioned by a preternatural enlargement of the thyroid gland. The tumour is free from pain, generally of the natural colour of the skin, does not readily inflame, and is not of a malignant character. Often the swelling is rather a deformity than an inconvenience; but occasionally, and especially when the tumour is large, it causes serious evil, by obstructing the voice and the respiration.

When the swelling first appears, it is soft, spongy, and elastic; after some time it assumes a more firm and fleshy consistence, being however firmer in some places than in others, and it gradually spreads towards each side of the neck until it attains in some cases a prodigious magnitude. In general the swelling affects the whole gland, but occasionally only one lobe is enlarged. When the swelling attains a great size, and the lower part of the gland is more especially involved in the disease, the tumour hangs pendulous from the neck. On examining the interior of the gland, it is found to consist of innumerable cells of different sizes, which are all filled with a transparent viscid fluid. Nothing is known of the real nature of this disease. Little is ascertained of the causes which either predispose to it or which produce it. Many causes are assigned, which is commonly the case when no cause is known. Moreover, in the present instance, several of the causes assigned are contradictory. What is certain is, that there are countries, or rather particular places in certain countries,—for example, Switzerland, Savoy, the Tyrol, certain districts of South America, and some places in Great Britain, as Derbyshire,—in which the disease is *endemic* (common to the inhabitants of the same country, from some cause specially connected with that country). It is much more common in females than in males. In Great Britain it is very seldom seen in males, but in Switzerland, and in other places in which it is very prevalent, males are more often attacked than in Britain. It commonly occurs about the age of puberty, and in girls seems to be strictly connected with an irregularity in the female health. Dr. Copland says, "In a considerable number of cases which have come before me in females, I have never met with any before the period of commencing puberty,—not even at the Infirmary for Children; although the menses have often been delayed for a year or two, or even longer, when the tumour has appeared at this epoch; and I have seldom observed an instance in this sex unconnected with some irregularity of the menstrual discharge or disorder of the uterine functions. In two cases occurring in married females, who were under my care, unhealthy or irregular menstruation had existed during the

continuation of the goître; in one case for eight years, in the other for five; upon its disappearance pregnancy took place in both. Suppression of the menses has sometimes caused its sudden appearance and rapid development; and it more rarely has originated during pregnancy and the puerperal states. Authors have added conclusive proofs of its occurrence hereditarily, independently of endemic influence."

It has been said to have an intimate connection with poverty and bad food, the rich being comparatively exempt from it; but on this point the statements are conflicting. It has been very generally attributed to water used as drink, and more especially to snow-water; but the disease occurs where there is no snow, as in Sumatra and several parts of South America; the Swiss who drink snow-water are free from the disease, while those who use hard spring-water are prone to it. In his journey to the Polar Sea, Captain Franklin observed that at a part where bronchocele prevails, the disease is confined to those who drink river-water, while those who use melted snow escape. Mr. Bally ascribes its frequency in a district in Switzerland to the use of spring-water impregnated with calcareous or mineral substances; and he states that those who use not this water are free from both goître and cretinism. Dr. Coinder observed that the inhabitants of Geneva, who drink the hard pump-waters, are those most liable to bronchocele. Its prevalence in Nottingham is ascribed by Dr. Manson to the same cause; which also seems to occasion it in Sussex and Hampshire, in the valleys of which counties it is frequently met with.

It is unquestionably most frequent in low, moist, marshy, and warm valleys; even in the very districts in which it is endemic, the inhabitants of dry and elevated situations are exempt from it; but it is probable that the malaria of those places operates only as a predisposing cause, favouring the action upon the system of some unknown agent.

It is frequently connected with a tendency to scrofulous disease in this country, and is found in conjunction with cretinism in the Swiss valleys. [CRETINS.]

One of the most efficient remedies for the removal of bronchocele is iodine. It should be administered internally, and may be applied in the form of ointment externally. Iron and quinine may be combined with this treatment with advantage; but above all things, pure air is the most important.

Sometimes the larger forms of bronchocele resist all medical treatment, and, threatening life by pressure on the air-passages, they have been successfully removed by the surgeon's knife.

BRONCHOTOMY. [TRACHEOTOMY.]

BRONZE, an alloy of copper, tin, occasionally zinc, and a little lead. For casting statues, bronze has been used from the most remote antiquity. According to Pliny, this art was brought to a considerable degree of refinement 700 years before the Christian era. Ancient military weapons and tools were also frequently made of it. For the latter purposes steel has superseded this alloy, and bronze, strictly so called, is now used for little else than the casting of statues and medals. *Bell, gun,* and *speculum metal,* all largely used, are however merely varieties of bronze, and will be severally treated of in this article.

The essential characteristics of a metal to be used for statuary purposes are obvious. It must flow freely when melted and expand on solidifying, in order that the minutiæ of the mould may be accurately represented. It must be so tough and hard that it will be but little affected by accidental blows, and be composed of such substances as will yield an alloy on which the weather will have the least possible influence. All these requirements are exactly fulfilled by bronze: moreover, the slight action of air and moisture on this alloy by long exposure give to the statues a greenish tint, that to the eye is more agreeable than otherwise.

The following are specimens of the proportions of copper, tin, &c., which may be used in the manufacture of bronze; they may be slightly varied, according to the purposes for which the alloy is intended :—

	I.	II.	III.
Copper	96	89	87·25
Tin	4	8	9·75
Zinc		3	3·00
	100	100	100·00

No. 1 is the formula recommended by M. Chaudet: a bone-ash mould furnishes a perfect impression that only needs polishing. No. 2 assumes an antique appearance by age. No. 3 is an average of the proportions now generally used for medals. The celebrated statue of Louis XV. contained—

Copper	82·45	Specific gravity 8·482
Zinc	10·30	
Tin	4·10	
Lead	3·15	
	100·00	

Small quantities of bronze may be melted in crucibles,—large masses on the hearth of a reverberatory furnace. The molten metal should be occasionally stirred to prevent separation into layers, and the whole operation conducted as quickly as possible, to prevent waste of copper and tin by oxidisement, and zinc by volatilisation. This effect may also be prevented to a very great extent by covering the whole with a layer of small charcoal.

Gun- or Cannon-metal.—The best proportions of copper and tin for this alloy seem to be about nine of the former to one of the latter. Zinc and lead are never added. A larger quantity of copper causes the masses to separate on cooling into two layers; this may be avoided by very sudden cooling in thick iron moulds, or in water; but large cannon cannot be treated in this way.

Bell-metal always contains a much larger amount of tin than gun-metal. When suddenly cooled, it is soft, tough, and malleable, and in this state may be turned in a lathe and worked with considerable ease. By re-heating and slow cooling it is obtained hard, brittle, and sonorous. Some of the best specimens of bell-metal consist of—

	I.	II.	III.	IV.	V.
Copper	78	82	80	75	72·00
Tin	22	18	10·1	25	26·56
Zinc			5·6		Iron, 1·44
Lead			4·3		
	100	100	100·0	100	100·00

No. 1 is very fusible and sonorous. No. 2 is the composition of the Chinese *gong-gongs*; it should be very suddenly cooled. No. 3: old English bell-metal. No. 4: excellent for church bells. No. 5: proportions, according to M. Berthier, of the ornamental French clocks or pendules. For similar purposes, a little zinc increases the sharpness of the tone.

Speculum metal, used in the preparation of specula for reflecting telescopes, has still less copper and more tin than bell-metal. It frequently contains also a little metallic arsenic, which is supposed to render it whiter; thus:

	I.	II.	III.	
Copper	64·5	66·6	68·2	or (Cu_4 Sn)
Tin	32·2	33·4	31·8	
Arsenic	3·3			
	100·0	100·0	100·0	

The proportions in No. 3 were used by Lord Rosse in the manufacture of his celebrated reflector.

The materials of speculum-metal should be thoroughly incorporated when in the melted state by brisk stirring with a wooden spatula, and the mould so arranged that the bottom shall receive the intended upper surface of the mirror; this part will therefore cool first, and give the most perfect casting. This variety of bronze is exceedingly brittle, a slight blow, or the incautious application of even a gentle heat, causing its fracture; the polishing of specula must therefore be performed with great care. For this operation, Mr. Potter recommends peroxide of iron, prepared by precipitating sulphate of iron with ammonia, washing the precipitate with water, and heating to dull low redness.

Composition of varieties of ancient bronze:

	a	*b*	*c*	*d*
Tin	12	22·02	19·66	26·74
Copper	88	77·60	80·27	73·00
	100	99·62	99·93	99·74

	e	*f*	*g*	*h*
Tin	26·0	19·5	3	15
Copper	71·0	80·5	97	85
Zinc	1·8			
Iron	1·2			
	100·0	100·0	100	100

a. Bronze from Celtic vessels, swords, and spears. (Clarke, 'Ann. Phil.,' 7, 73.) *b.* Arrow-head from an Egyptian tomb. *c.* Cast coffin from Altai, on the borders of China. *d.* Another coffin. (Göbel, 'Schw.,' 60, 407.) *e.* Old bell at Rouen, known by the name of *Cloche* d'Argent. (Gerardin, 'Ann. Chin. Phys.,' 50, 205.) *f.* Chinese *gong.* (Thomson, 'Ann. Phil.,' 2, 209.) *g.* Bronze springs for the Balistæ, according to Philo of Byzantium. *h.* Antique sword, found in the environs of Abbeville.

Bronze is slowly attacked by boiling hydrochloric acid, tin being extracted, leaving copper containing a small quantity of tin. Nitric acid dissolves it readily.

BRONZE, Ital. *bronzo;* Fr. *bronze;* Gr. χαλκὸς (chalcos); Lat. *æs,* is essentially a compound of copper and tin, which metals appear to have been among the earliest known. Copper is not unfrequently found in its metallic state, and fit for immediate use; and tin, though not so met with, often occurs near the surface, and its ore is easily reduced. These metals, though neither of them possesses the hardness requisite for making instruments either for domestic or warlike purposes, appear to have been early found capable of hardening each other by combination; the bronze, which is the result of this combination, consisting of different proportions of them, according to the purposes to which it is to be applied.

Bronze is always harder and more fusible than copper; it is highly malleable when it contains 85 to 90 per cent. of copper; tempering increases its malleability; it oxidises very slowly even in moist air, and hence its application to so many purposes. The density of bronze is always greater than that of the mean of the metals which compose it: for example, an alloy of 100 parts of copper and 12 parts of tin is of specific gravity 8·80, whereas by calculation it would be only 8·63.

The precise etymology of the word "bronze" has not been ascertained; but it is first met with in Italian writers to express this mixture of metals, and it is not very improbable that it is a corruption from the Italian *bruno*, which signifies *brown;* the bronze of the Italian, and particularly the *cinque cento* schools, being of that colour which is nearly the original tint of the material when left in its natural state. The green hue that distinguishes ancient bronzes is acquired by oxidation and the combination of carbonic acid: and the moderns, to imitate the effect of the finer antique works, sometimes advance that process by artificial means; usually by washing the surface with an acid. Vasari alludes to this practice among the artists of his time, and to the means they adopted to produce a brown, a black, or a green colour in their bronze. ('Vit. dei Pittor.' Introd.) The Greeks and Romans, in speaking of works in bronze, used words which at once referred to the metal; the Greek *chalcos* being a mixture of copper and tin, and the Roman *æs* the same. These words are often understood by moderns to denote brass, which is however a different composition, being a mixture of copper and zinc.

Though there is no doubt that the uses of some of the metals were known very early, there is unfortunately little or no information either on the mode of working them or of the time of their discovery. It is clear however that, for a long period, copper, if not the only metal known, was at least the most abundant; for we find it was employed universally for arms, ornaments, and utensils, domestic and agricultural. Iron was apparently of much later discovery. The simpler processes of metallurgy seem to have been practised at a very remote date both in Asia and Egypt. On this subject the Old Testament is our best authority, and the accounts we there find lead us to believe that considerable skill had been attained by the very earliest nations. Tubal-cain was, we are told, a great worker in metal. Among the earliest allusions to works in metal in the Books of Moses is the mention made of the presents offered to Rebecca: Abraham's servant gave her "a golden ear-ring of half a shekel weight, and two bracelets for her hands of ten shekels weight of gold;" and spoke to her of his master's riches, particularly mentioning silver. (Gen. xxiv. 22.) The accounts of the ornaments and utensils in the history of Jacob, and of Joseph, and in various other passages of the Old Testament, prove in like manner the extensive employment of metals at that time; and their being applied to purposes of luxury indicates that considerable progress had been made in the art; long use naturally preceding any attempt at refinement. The earliest recorded names of sculptors (and they are metal-workers) are in the Old Testament. One was "Bezaleel, of the tribe of Judah, who was filled with the spirit of God, in wisdom, and in understanding, and in knowledge, and in all manner of workmanship, to devise cunning works, to work in gold, and in silver, and in brass," &c. &c.: with him is associated Aholiab, of the tribe of Dan. They were the artists appointed to execute the works of the Tabernacle. (Exod. xxxi.) Among the Egyptians also the employment of metal was known in times prior to any historical record; and it is probable that the metallurgical knowledge possessed by other countries was derived directly or indirectly from this source. Among other proofs of this, the casting of the golden calf by the Israelites may be cited. It is remarkable, however, that among the remains of bronze works of art that have been discovered in various parts of Egypt, none have been found of large dimensions. Some of the most remarkable early works in metal mentioned in history are those recorded by Diodorus Siculus, who in this part of his history followed Ctesias, a Greek historian and physician contemporary with Xenophon. He describes works in gold and bronze which decorated the gardens of Semiramis, of such a magnitude, and representing so great a variety of subjects, that, if we are to place any confidence at all in the testimony of this writer, we must conclude that the Assyrians and Babylonians had attained very great proficiency in the arts connected with metallurgy. That the statements of Diodorus, which in fact are those of Ctesias, are to be received with some qualification, must be granted; but Mr. Layard found in the course of his excavations at Nineveh various bronze ornaments which had evidently been cast in a mould: several of these are in the British Museum. M. Botta also discovered among other metal articles in the palace of Khorsabad, a very finely moulded bronze lion.

The skill and enterprise of the Phœnician people gave them a commanding station among the ancient nations, and they must have materially influenced the civilisation not merely of neighbouring but of remote countries; but unfortunately the monuments that can be referred to a Phœnician origin are too few, and for the most part of too distant a date from the brilliant epoch of the Phœnician nations to be fairly quoted as specimens of original taste or practice. Their supposed traffic with Britain furnished them tin, or probably they procured it from Spain or Eastern Asia. Homer has immortalised the Sidonians with the distinguished title of "Σιδόνες πολυδαίδαλοι," *the Sidonians the skilful workers.* The artificer employed by Solomon in

the decoration of the Temple (about 1000 years before our era) was Hiram, a native of Tyre, "who was cunning to work all works in brass." (1 Kings vii.) These works, we are told, were *cast* and wrought.

We know so little of the earlier history of the arts in India, that we must be satisfied with observing that many specimens of their bronze works, of which we possess some curious examples in this country, as idols, utensils, &c., may be referred, without doubt, to an extremely remote date; but the slight changes that have taken place in the style of their art and workmanship prevent any classification of them, or even an approximation to the times at which any of the more ancient were executed.

The works that remain of the Greeks, whether considered with reference to the illustration of their history, or for the exquisite specimens which they offer of their taste and feeling in imitative art, claim our especial regard, and the names of few sculptors, or rather statuaries, of celebrity have reached us who were not chiefly distinguished for the excellence of their productions in bronze. In the time of Homer, the scarcity of iron occasioned the general use of other metals; and we find the arms, offensive and defensive, are always described as being made of bronze, or perhaps copper alone, which it is possible they had some means of tempering and hardening. The art of casting statues seems to have been first practised in Asia Minor; Greece, properly so called, being probably too uncivilised to undertake such works. The Lydians and the Phrygians were early distinguished for their skill in these arts, and they were probably the teachers of the Greeks.

The records to be depended upon as to Greek art go as far back as between 600 and 700 years B.C., and the mode of working metal at that time seems to have been the same, or nearly so, as far as there are means of judging, as that adopted by other and earlier nations. The first and most simple process appears to have been hammer-work; that is, lumps of the material were beaten into the proposed form; and if the work were too large to be made of one piece, several were shaped, and the different parts fitted and fastened together by means of pins or keys. Pausanias (iii. 17) particularly describes this process in speaking of a very ancient brass statue of Jupiter, at Sparta; and this mode of working (mentioned by Herodotus, vii. 69) is called by him and others σφυρήλατον (*sphurélaton*), "hammer-worked," in opposition to the term ἔργα χωνευτά (*chōneuta*), applied to "works that were cast." This statue of Jupiter was the work of Learchus of Rhegium, and Pausanias says it was the most ancient statue of the kind; by which he probably only means that it was of the most archaic or ancient style, as Herodotus, Diodorus Siculus, and others, as well as Pausanias himself, refer to other works of a more remote date. Pliny (xxxiii. 4), in speaking of a solid gold statue of Diana Anaïtis, refers to a mode of execution termed Holosphyraton (derived from three Greek words, signifying "entire," "solid," and "hammer"). It was so called probably to distinguish it from another kind of hammer-work, in which plates of metal were beaten out into the form desired on a nucleus of another material, of which, as some believe, a curious specimen of ancient Egyptian workmanship may be seen in the British Museum. This process is alluded to in Homer ('Odyss.' iii. 425); and as early as Moses, the brazen censers of the disobedient were, by the lawgiver's command, *beaten out into plates* for covering the Tabernacle. The most ancient civilised inhabitants of India seem to have adopted the same manner of working in laminæ, or plates; there is an example of it in the British Museum, in a figure of Buddha. A great saving of metal was effected by this process.

Soldering (κόλλησις), or the art of uniting the parts of metals, is attributed (Herod. i. 25) to Glaucus of Chios, a contemporary of Alyattes, king of Lydia. The art of soldering iron is attributed solely to Glaucus. (Compare Pausan. x. 16. with Herod. i. 25.)

It is extremely difficult to determine when the art of metal-casting in regular moulds was first practised. It was undoubtedly known very early, though its adoption in European Greece is probably of a comparatively late date. Its progress was evidently marked by three distinct stages. The first was simply melting the metal into a mass, and then beating it out either as solid hammer-work, or in plates. The next was casting it into a mould or form; the statue being of course made solid. The last, which argues considerable knowledge and skill, was casting it into a mould, with a centre or *core* to limit the thickness of the metal. The first artists who are celebrated by the historians of Greek art for their success in metal-casting are Rhœcus (who is said to have invented the casting of metal), Theodorus, and Telecles, natives of Samos (Herod. i. 50; Paus. viii. 14; Plin. 'N. H.' xxxv. 12); and the manner in which they are spoken of proves that their works were held in high estimation long after their own time. There is some difficulty in fixing their date with precision, as there were two or three of the same names, but it seems probable that the first artists so called lived between 700 and 600 B.C. Theodorus is made by Herodotus the contemporary of Crœsus, who was defeated by Cyrus B.C. 557. Gitiadas of Sparta and Glaucias of Ægina hold also a distinguished rank among the earlier artists in bronze; to whom we might add a long list. Herodotus (v. 77) says that four bronze horses were made by the Athenians from the tenth part of the value of the ransom of the Bœotians and Chalcidians: the horses were placed at the entrance of the propylæa on the Acropolis, with an appropriate inscription. The

ancient artists do not appear to have considered it important to cast their statues entire, for Pliny acquaints us with the composition used for soldering the parts together. The finest collection of ancient bronzes, taking it as a whole, is at Naples; among the specimens there are some very curious for the manner in which the ringlets of hair, worked separately, are fastened on; many of these are the size of life. Bronze-casting seems to have reached its perfection in Greece about the time of Alexander the Great, 330 B.C. The accounts given of the works executed about that time almost exceed credibility. After Lysippus, the favourite sculptor of Alexander, who executed, according to Pliny (xxxiv. 8), above 600 works, the art declined.

The ancient statuaries seem to have been extremely choice in their selection and composition of bronze. Two of the most celebrated, contemporary with Phidias, carried their rivalship so far as to employ bronze of different countries; Polycletus preferring that of Ægina, while Myron always used that made at Delos. The ancients seem to have had a method of running or welding various metals together, by which they were enabled to produce more or less the effect of natural colour. Some works are described that were remarkable for the success which attended this curious, and to us unattainable, process. They also tinted or painted their bronze, with the same view of more closely imitating nature. (Callistrat., Stat.; Plin. xxxiii. 9; Plut., 'Symp.' lib. v., and others; see also Quatremère de Quincy, 'Jup. Olymp.') The story of the accidental mixture of the most precious bronze used by the ancients, namely the Corinthian, has been too often repeated to require further notice here. Pliny himself refutes the story which he records. He informs us also that there were three sorts of the Corinthian bronze. The first, called candidum, received its name from the effect of silver which was mixed with the copper; the second had a greater proportion of gold; the third, Pliny says, was composed of equal quantities of the different metals. The ancient writers mention several of the bronzes that were used; amongst them we find Æs Hepatizon, or liver-coloured; Æs Deliacum, and Æs Ægineticum—Plutarch says the composition of the Delian brass was a secret lost in his time—Æs Demonnesium, Æs Nigrum, and lastly Tartessian bronze (Ταρτήσσιος χαλκὸς), of which, it must be confessed, we know little or nothing beyond their titles. The analysis of a few specimens of bronze of undoubted antiquity, namely, a helmet with an inscription (found at Delphi, and now in the British Museum), some nails from the treasury of Atreus at Mycenæ, an ancient Corinthian coin, and a portion of a breastplate or cuirass, of exquisite workmanship, also in the British Museum, affords about 87 or 88 parts copper to about 12 or 13 of tin per cent. The experiments of Klaproth and others give nearly the same results as to ingredients; the quantities sometimes differ slightly; lead is contained in some specimens. Zinc has not been found in any quantity sufficient to warrant a belief that it was intentionally introduced: indeed, it is thought that its nature was not understood by the ancients. In an antique sword found many years ago in France, the proportion in 100 parts was 87·47 of copper to 12·53 of tin, with a portion of zinc so small as not to be worth noticing (Mongez, 'Mém. de l'Instit.'). The same may be observed of minute portions of silver that have sometimes appeared in bronze. ('Antichit. di Ercolano.')

The Romans never attained any great eminence in the arts of design. Their earliest statues were executed for them by Etruscan artists. Rome however, as the conquests of that warlike people were extended, was soon filled with a prodigious number of works of the best schools of Greece; and artists of that country, unable to meet with employment at home, settled in the capital of the West. Zenodorus executed some magnificent works in the time of Nero, particularly a colossal statue of the emperor, 110 feet high. But Pliny, who lived in the reign of Vespasian, laments the decline of the art and the want of skill of the artists in his time. It is even said that the art of casting bronze statues was lost. This assertion is, however, totally unfounded; for it appears that a Greek sculptor, Celon, was highly distinguished under Domitian, and one of his works, a colossal equestrian statue cast in bronze, is much celebrated; and there is no doubt that the art was well known under Trajan, Hadrian, the Antonines, and even much later.

The practice of gilding bronze statues does not seem to have prevailed till taste had much deteriorated, and when the richness of material was more highly thought of than the excellence of workmanship. Pliny tells us that Nero commanded a statue of Alexander, by Lysippus, to be gilt; but when done it was found to have so much injured the effect or beauty of the work, that the gold was by the emperor's orders removed. The injury was doubtless occasioned by the glitter and sparkling of the light upon the projecting and shining surfaces, destroying the breadth, and consequent grandeur and unity of effect secured by the more sober colour of the bronze. The practice of art among the Romans declining rapidly, and with but few interruptions, ceases to interest us about 200 A.D. In the beginning of the 13th century, at the taking of Constantinople, we read that some of the finest works of the ancient masters were purposely destroyed, either with the object of converting the material into money, or for sale to the brass-founders, for the mere value of the metal. Among the few works saved from this devastation are the celebrated bronze horses, which now decorate the exterior of the church of St. Mark at Venice.

Passing over the intermediate age of darkness and barbarism, we arrive at the epoch of the revival of art in Italy, under the Pisani and others, about the 14th and 15th centuries. The celebrated bronze gates of the Baptistery at Florence, by Ghiberti, which M. Angelo said were fit to be the gates of Paradise, are among the more remarkable works of the time. In the succeeding century we find Guglielmo della Porta practising the art with so great success, that he obtained the flattering notice of Michel Angelo; and he is distinguished by Vasari ('Vit. di Leone Leoni') for adopting a mode of casting that was considered quite original, in executing his colossal statue of Paul III. The metal, when run from the furnace, was carried downwards by a duct, and then admitted into the underside or bottom of the mould (nel bagno da basso); and thus, acted upon by superior pressure, as in a common fountain, was forced upwards till the mould was entirely filled. It is necessary in this process that the mould should be kept in a state of great heat, in order that the metal may not cool before the whole is run. But among the artists who are celebrated for their skill in bronze-casting, Benvenuto Cellini holds a most distinguished rank: there are few collections that cannot boast some specimens of his smaller productions, while the larger works that remain, particularly at Florence, prove that his high reputation was not undeserved. In his interesting and romantic autobiography he gives some curious particulars on metal-casting; and an anecdote which he tells respecting one of his works illustrates an important fact in the process, while, at the same time, it is highly characteristic of the impetuosity of the man. Copper alone is thick and pasty, and therefore incapable, without some alloy, of running into all the cavities and sinuosities of the mould; a small mixture of tin is therefore usually added to give it the quality necessary for producing what is called a true cast. He was engaged on his fine group of Perseus and Medusa, during which, by the jealousy of rivals and the ill-conduct of his workmen, he had been subjected to every kind of annoyance and disappointment. At length his labours seemed to be nearly at an end: his mould was lowered into the pit, the furnace heated, and the metal thrown in. At this time, while a violent storm raged without, the roof of his study, as if to increase the confusion, caught fire; but though ill and harassed, he still directed the works and encouraged his assistants, till overcome by anxiety and fatigue he retired in a raging fever to lie down, leaving instructions respecting the opening of the mouth of the furnace, and the running of the bronze. He had not, he says, been reposing very long before one came running to him to announce evil tidings: the metal was melted but would not run. He jumped from his bed, rushed into his studio like a madman, and threatened the lives of his assistants, who being frightened got out of his way, till one of them, to appease him, desired him to give his orders and they would obey him at all risks. He commanded fresh fuel to be thrown into the furnace, and presently, to his satisfaction, the metal began to boil. Again however it appeared thick and sluggish, and refused to run. He then ordered all the plates, dishes, and other articles of domestic use in his house to be brought to him, which he threw pell-mell on the metal, when it immediately became fluid and the mould was soon filled. He adds, that he fell down on his knees, and poured forth a fervent thanksgiving to Almighty God for the success that had crowned his exertions. In the processes above described the metal was allowed to flow at once from the furnace into the channels or ducts of the moulds. The statue of Louis XIV., by Girardon, one of the most celebrated sculptors of France, was cast somewhat differently, though with equal success. The wax which regulated the thickness of the metal being entirely melted out, and the mould fixed in the pit, with the necessary vents for the escape of the air, the metal was allowed to run from a furnace, placed considerably above, into a sort of trough or basin. In this were three apertures, closed by plugs, immediately over the chief channel or conduit by which the metal was to be conveyed into the mould. These, by a mechanical contrivance, were opened simultaneously, when the metal descended at once into the mould. This group was cast entire.

The more modern practice of the English, French, Italian, and German artists does not differ materially in its principle from that of the earlier Italians. Some however use what is called a cupola-furnace, and others a blast-furnace. The mode practised in Sir R. Westmacott's foundry, where many of the chief colossal as well as other works that have been produced in this country have been cast, will serve to explain the methods now adopted: of course, there are variations of more or less extent in the modes of procedure peculiar to every foundry. The moulds, composed of a mixture of plaster of Paris and brick-dust, are made in the usual way on the plaster-cast models. A lining of wax or clay is then made within the mould, of the proposed thickness of the metal. The mould thus lined being then put carefully together, the space or interior is filled up solid with a mixture of plaster and brick-dust, &c.: this is called the core. The whole now consists of three parts—the mould, the lining of wax or clay (which represents the metal), and the core. When the mass forming the core is set, and fixed with irons and keys to preserve it in its just position, the mould is again taken to pieces, and the wax or clay removed; the channels for distributing the metal and vents for the escape of the air are then made, and the whole being put together is placed in a stove or oven to be dried. When perfectly free from any humidity (a most important point, as the slightest damp might occasion fatal consequences by the

bursting of the mould when the boiling metal descends into it), the whole is carefully lowered into the pit, and closely rammed down with sand, &c., to prevent its moving; the channels for the metal to enter and the vents for the escape of the air being of course kept perfectly clear. When the metal is ready for running, the mouth of the furnace, which is placed rather above the level of the top of the pit, is opened, and the bronze descends immediately into the mould. The mixture of metal preferred by the above-mentioned sculptor is that used for casting guns, to which he adds about 30 per cent. of pure copper, extracting from 3 to 4 per cent. of tin. In modern practice it is not, by many of the most successful founders, considered important to cast the whole work at once: on the contrary, in case of accidents, which however are of very rare occurrence, there is an advantage in being able to repair parts; and the process of burning, successfully adopted by Westmacott and others in the largest works (and which is found a great improvement on the ancient method of soldering), renders the joined portions even firmer or stronger at their point of junction than the general body of the cast. A description of the method of casting adopted in other foundries, differing somewhat from the above, will be found in the Introduction to Mr. D. Wyatt's 'Treatise on Metal work.'

This short history of bronze casting is purposely limited to its reference to the Fine Arts; and though, in speaking of celebrated productions or artists, it has been considered advisable to introduce incidentally such particulars of practice as might tend to illustrate the subject, the details of the various processes of moulding, coring, melting, chasing, &c., &c., are omitted, as belonging more properly to founding and casting. [FOUNDING.]

No particular reference has been made to the bronze weapons and ornaments of the ancient northern nations, as they could not properly be regarded as works of Fine Art, and they will be spoken of elsewhere. Here it will be sufficient to mention, that in the barrows and other sepulchral places of all, or nearly all, the northern races, bronze articles are found in great numbers, and of a kind to show considerable skill in the artificers. Most museums of antiquities contain numerous specimens; and by northern antiquaries the presence of bronze articles is regarded as a mark by which to assign the age of the person buried in the tomb,—the "bronze period" being one of their great divisions of "primeval antiquity."

The composition of different kinds of bronze will be found in the preceding article.

BRONZING; BRONZE POWDER. Much ingenuity is displayed in imitating the colour of ancient bronzes—both the greenish and the rich golden tints. Metals, wood, and plaster, are all subject to surface-processes having this object in view.

Captain Pidding states that the Chinese exercise the art of bronzing in a very superior manner. After having rubbed the vase or other ornament with coal-ashes and vinegar, they dry it in the sun, and then coat it with a composition, of which the following are the ingredients: two parts of verdigris, two of cinnabar, two of sal-ammoniac, two of the beak and liver of duck, and five of pounded alum: moistened to the consistency of a paste. When the article is thus prepared, it is passed through the fire, and washed when cold; again it is coated with the composition, again fired, and again washed; and so on for several times in succession.

Becquerel introduced to the notice of the Académie des Sciences, several years ago, a method of bronzing, in which a thin layer of bronze is applied to the surface of any article of iron, steel, lead, zinc, tin, or other metal. It is effected by precipitation from a solution, through the agency of a galvanic battery, in the usual manner of electro-metallurgy; but the difficulty to be surmounted consists in the discovery of a proper solution. The solution described by Becquerel consists of carbonate of potash, chloride of copper, sulphate of zinc, and nitrate of ammonia: with a plate of brass or bronze as a positive electro-decomposing plate.

A process of bronzing on paper is now frequently adopted for ornamental purposes. Thin plates of copper, or of copper alloyed with some other metal, are beaten out into thin leaves, and these leaves are ground or worked to powder. A pattern is printed on the surface of paper with an adhesive and rapidly-drying varnish; and just before this varnish is dry, the bronze powder is rubbed on with a piece of soft cotton, whereby a metallic lustre is produced, varying in its tint from a bright gold to a deep red colour, according to the metallic constituents of the bronze powder. Sheets of paper, thus bronzed after having been glazed and printed in various colours, now form highly adorned coverings for albums and many other kinds of books. In some of the recent novelties in colour-printing, this mode of bronzing is adopted as an adjunct.

BROWNING is a process applied to gun-barrels. Various liquids are used for this purpose, comprising two or more ingredients from a long list including aquafortis, spirits of nitre, blue vitriol, muriate of iron, butter of antimony, sweet oil, &c. The gun-barrel being well polished, and the oil removed by means of whiting, the browning solution is laid on, allowed to remain several hours, and then rubbed; these alternate processes are repeated two or more times. The barrel is afterwards cleansed with alkaline water, and polished. The natural colour of the wood-work, and the artificial tint imparted to the barrel, probably originated the designation of "Brown Bess," applied to the army musket.

BROWNISTS. [BROWN, ROBERT; in BIOG. DIV.]

BRUCIA BRUCINA, BRUCINE, called also "Vomicina." *Medical Uses of.*—The alkaloid above described exists in several species of *strychnos*, as well as in the bark of the false angostura; and as it is admitted on all hands that this bark is not obtained from any species of brucia, it has been proposed to change the name to *Caniramia* (derived from Caniram, and the name under which the strychnos nux vomica is described in Rheede, 'Hort. Malabaric.,' vol. i. p. 67). The names are quite unobjectionable, as it exists in the strychnos nux vomica along with strychnia; but it is far from certain that the false angostura is the bark either of the strychnos nux vomica or of the strychnos colubrina, as conjectured by Virey. [GALIPEA.] It is most probably obtained from some undescribed South American species of strychnos.

Caniramin acts on the human system as a poison, and in precisely the same manner as strychnia, but more gently, being much less powerful. Hence it has been proposed to be substituted for it. The same precautions must be observed in its use, and the same contra-indications attended to. The cases in which it is most likely to prove useful are paralysis from lead, diarrhœa from atony of the intestines, and perhaps cholera asphyxia or Indian cholera. It is important to bear in mind that the anhydrous state of the salt is one-fifth more powerful than the crystallised. In case of poisoning, emetics may be given, and also tincture of bromine or iodine. [STRYCHNOS.]

BRUCINE. [NUX VOMICA, ALKALOIDS OF.]

BRUNOLIC ACID. This acid, the composition of which has not yet been determined, was found by Runge amongst the tarry products of the destructive distillation of coal. It is brown, vitreous, and easily reduced to powder.

RRUNSWICK GREEN. [GREEN.]

BRUSH; BRUSH-MAKING. The chief distinction in brushes is that between what may be called *simple* brushes, which consist of a single bundle or tuft of hair; and *compound* brushes, consisting of several small tufts, separately inserted in a handle. Of simple brushes, an illustration is afforded by the camels' hair pencil, the manufacture of which is described under PENCIL. These hair pencils are made of every variety of size, from the smallest pigeon or crow quill to the largest quills of the goose, turkey, or swan; and as even the largest quills are not large enough for some kinds of brush or pencil, while in other cases quills are not sufficiently strong and durable, tin tubes are occasionally substituted for them, the handle or pencil-stick being then firmly fixed in the tube. Even the smallest kinds of pencil made of bristles, or of the harder kinds of hair, for oil-painting, are usually mounted with tin, and are known by the general name of *tools*. For some purposes, tin mounted tools are made flat instead of round; the hairs being arranged in a flat, or chisel-like, instead of a cylindrical form. The larger kind of bristle tools are not inserted in tubes, but are bound round very tightly and tied to the end of a wooden stick or handle, which is cut into a forked shape, so as to have a projecting fin on each side of the bundle of hairs.

Other brushes have the handle inserted in the tuft. Among these are the large painting and dusting brushes used by house-painters, the bristles of which are first tied or wrapped round, with the smaller end of the conical wooden handle in their centre. The brush is then placed upon a block of iron perforated with holes to receive the handle, with the points of the bristles uppermost; and the conical handle is driven in with considerable force, until the greater part of its length has passed through the brush to form the handle, while the thicker end remains in the middle of the tied portion as a sort of core. Excepting in the peculiar mode of tightening the brush by the insertion of the handle, carpet-brooms and birch-brooms resemble, on a larger scale, this kind of brush.

Intermediate between the simple and compound brushes are white-wash and distemper brushes, which consist of two or more simple brushes placed side by side, and secured separately upon the edge of a flat handle.

Of compound brushes, which consist of numerous tufts or pencils of bristles or fibres, technically called *knots*, inserted separately in holes, the holes are bored in the stock, or back, by the aid of a lathe and borer. The mode of fixing the knots in 'pan-work' or 'set-work,' is as follows: The brushmaker arranges evenly a sufficient quantity of bristles to form a knot which will just enter one of the holes in the stock. Grasping these firmly, he dips the even end into a pan of melted pitch and tallow, then scrapes off the superfluous pitch, and afterwards takes a piece of strong thread called a *thrum*, and quickly binds it round the bristles. The end of the knot is then again dipped in the pitch, after which it is inserted in its proper hole in the stock with a peculiar twisting motion, which, coupled with the almost instantaneous setting of the pitch, renders it very firm and secure. In this way are manufactured long-brooms, bannister-brushes, hearth-brushes, and many other kinds of house-broom, and also many of the lighter kind of brushes, such as the dusting-brushes used for pictures and furniture.

In most of the brushes hitherto described, the bristles are used of their full length, or are very little cut; but in such brushes as are used for scrubbing or hard rubbing, the tufts are made short and cut at their ends to a square even surface, and the root ends of the bristles brought to the surface as much as possible. Clothes-brushes, and some

other brushes of this character, are occasionally made by the process last described.

Short and stiff-haired brushes are usually made by the 'drawn' method, instead of the 'set-work' method. The stock of a drawn brush is bored in a similar manner to that of a set brush, but more carefully. After each knot-hole has been bored just as far as the knot is intended to go, a smaller boring instrument, called a *bore-through-bit*, is fixed in the lathe, and with it a small hole is bored completely through the stock, in continuation of each knot-hole. The brush-maker then, instead of taking in his hand as many bristles as will fill the hole, takes about half that number, and passes a portion of their root-ends through the bight of a fine wire, which, with the other hand he has passed double through the stock from the small hole which penetrates it. Having done this, he gives a smart pull to the wire, the effect of which is to pull it back through the hole so far as the knot will allow it to come, the knot itself being, at the same time, drawn into a bight or double, which enters the hole in the stock, and is drawn in until stopped by the shoulder which is formed at the narrowing of the hole. Passing his wire, which is almost as pliable as thread, through the next hole, the workman applies another knot in like manner, and so on until a row is completed, when he cuts the ends of the whole row off with a pair of powerful shears, to which is attached by screws a gauge to regulate the precise length of tuft to be left. As the drawing-wires at the back of the stock would, if exposed, hurt the hand and be very liable to injury, it is usual to cover them, even in the commoner kinds of brushes, with a thin piece of wood as a veneer. Drawn brushes comprise all kinds of scrubbing-brushes, shoe-brushes, clothes-brushes, and tooth and nail-brushes. As veneering would be a difficult operation to perform upon tooth-brushes, these and other small brushes mounted in bone or ivory are frequently drawn with silver wire, which is either left visible, or sunk in fine grooves cut in the back of the brush, which are afterwards filled up with a hard red cement; but in the best sorts a very ingenious process called *trepanning* is substituted for the ordinary mode of drawing. In trepanned work the drawing holes are not continued through to the back of the stock, but are formed laterally in its thickness, from the end or sides, in such a way that after the drawing, which is then performed with thread or silk instead of wire, is completed, all traces of the operation can be concealed by filling up a few minute holes in an unconspicuous part of the stock with small plugs of bone or ivory.

The operation of drawing, in the larger and coarser kinds of work, requires great strength of hand and arm, and is performed by men. In the finer kinds of brush-drawing, in washing and picking the bristles, and in various operations connected with the manufacture of fancy brushes, women are extensively employed; and as the manufacture is one usually conducted upon rather a small scale, so as to partake of the character of a private or domestic manufacture, it appears to be well adapted for the employment of females and children.

There are a few other kinds of brush, such as bottle-brushes (consisting of tufts fixed so as to radiate from a stem of twisted wire), which it is needless here to particularise. Dr. Ure described a mode of fixing the knots or tufts of brushes in dovetailed grooves formed in the stock, which was the subject of a patent granted in 1830 to Mr. Mason. More recently a patent has been obtained by Mr. Hancock for the manufacture of flexible back brushes, in which the knots are attached to yielding backs of leather instead of wooden stocks, and for some purposes such brushes seem to possess considerable advantages over those of the common construction.

Of the materials employed in the brush manufacture the most important are hogs' bristles. [BRISTLES.]

An ornamental appearance is often produced by the insertion, in one brush, of knots of picked bristles of various colours; and it is a common practice to put white or yellow bristles at the outside of a brush intended to look neat, while the centre is filled with those of a dark colour. For very soft brushes, such as hat-brushes, horse-hair, goats'-hair, and other kinds of hair are used; and for purposes which require unusual stiffness, fibres of whalebone, either alone or mixed with bristles, are sometimes employed; but the present high price of whalebone restricts its use. For very coarse brooms, for stable and out-door use, a hard and tough dark-coloured vegetable fibre called *bass* is much used: brooms made of it superseding, in a great measure, those of birch or heath. *Wisk* is a light-coloured vegetable substance of much finer quality, used principally for carpet brooms; and a very fine article of the same character has been recently employed in making brushes for velvet. The woods chiefly used for the stocks of the common kinds of drawn brushes are beech and oak, and among those employed in ornamental articles are sycamore, lime, rosewood, and satinwood. For brooms, in which lightness is desirable, alder and birch are much used. The wire employed for drawing is mostly a peculiar kind of brass wire made for the purpose, copper having been found too brittle; but a very superior article of compound metal, which has much the appearance of copper, but is very strong in proportion to its extreme tenuity, and soft and pliable to a degree which appears surprising in any metal, has recently been introduced under the name of red brass wire.

Mr. Cole, a brush-manufacturer, took out a patent in 1842 for numerous improvements in brush-making. In the general modes of making brushes the bristles are fixed in their places either by some kind of cement or by wire; but in Mr. Cole's method the knot of bristles is kept in each hole by the hole being made of a conical shape, with the smaller end of the cone at the face or hair side of the brush: the knot is so shaped that it maintains its place in the brush without either cement or wire. A second improvement consists in steeping in a preservative solution the string with which some brushes are bound round, so as to enable them to be placed in water without loosening. A third consists in a new mode of fastening wedge-shaped handles into various kinds of brushes. A fourth consists in the manufacture of a new kind of brush for delicate purposes, by making a covering of plush to a foundation of white flock. A fifth consists in making brushes or pencils of spun glass, by which aquafortis and other corrosive acids can be applied by silversmiths and jewellers with more delicacy and safety than by any of the usual means. A sixth improvement is in the construction of brushes intended for cleansing decanters and bottles. A seventh relates to brushes for cleaning cruets and small phials.

Numerous patents appear from time to time, relating to new forms of brush. Some are ingenious and useful; others are singular, without any great chance of being useful. One patent relates to a project for making brushes and brooms of the branches of the cabbage palmetto tree, in such a way that the handle shall form one piece with the brush. Another is for a mode of setting the bristles of an ordinary brush diagonally, by which arrangement, more of them are brought into action at once, and the surface of the brush is firmer. A third is a boiler-cleaning brush: the brush, by the aid of certain wedges, is made to expand and contract, so as to suit the diameters of different kinds of boiler-flues. A fourth is a boot- and shoe-cleaning machine, comprising two discs having brushes on their edges; treddles give motion to the discs, and the boot or shoe is simply held against the brushes. Many of the forms of knife-cleaning machines consist mainly of two sets of brushes revolving in contact, or nearly so; and the revolution being in opposite directions, great friction is brought to bear on the two surfaces of the blade of a knife thrust between the brushes. One of the oddest of these novelties is a mode of applying galvanic treatment to the hair, by brushes, of which some of the hairs (if they can so be called) are copper wire, and others zinc wire; a roll of flannel damped with some acid is to be enclosed in the wood-work of the brush, in such a way as to communicate moisture to the discs; and the theory of the inventor seems to be that galvanic action, useful in certain states of health or unhealth, would be produced by brushing the hair with a brush so constructed.

BRYOIDIN. A crystallisable substance, found in the resin of the *Canarium album*. It separates from a watery solution in fine silky filaments, which fuse at 275° Fahr., and volatilise slowly at the same temperature. Bryoidin is slightly soluble in cold, more so in hot water, and very soluble in alcohol and ether. Its solution is without action on turmeric paper, but it precipitates solution of acetate of lead.

BRYONIN. The peculiar principle of bryony-root to which the peculiar properties of the latter are owing; it is a yellowish white substance, sometimes with a red or brownish tint; its taste is at first rather sweet, then styptic and extremely bitter. It is soluble in water and in alcohol, but insoluble in ether; chlorine does not decompose it; sulphuric acid dissolves it, acquiring first a blue and afterwards a green colour. When decomposed by heat it yields ammonia (?) Alkalies do not alter it; the aqueous solution is precipitated white by nitrate of silver, yellow by chloride of gold, and white by protonitrate of mercury and by diacetate of lead; tincture of galls precipitates it of a bright gray colour. It is a drastic purgative, and poisonous in too large doses.

BUCCANEERS, a most numerous and well-known association of sea-robbers or pirates, who were also called 'The Brethren of the Coast,' and still more commonly 'Flibustiers.' The term Buccaneer is of curious derivation. The Caribbee Indians taught the colonists in the West Indies a singular mode of curing and preserving the flesh of cattle: when cured, this flesh was called *Boucan* by the Caribbees: from *boucan* the French made the verb *boucaner*, which the 'Dictionnaire de Trevoux' explains to be "to dry red, without salt." Hence comes the noun *Boucanier*, and our Buccaneer.

The term Flibustier is supposed to be nothing but the French sailors' corruption of our word 'freebooter;" and it is a curious fact, that as we always used a word corrupted from them, so the French designated the robbers by a word derived from us, invariably calling them flibustiers, or freebooters. The Americans of the United States have farther modified the word into filibuster, and use it to designate those who undertake wars against foreign countries without the sanction of the state.

The Buccaneers were natives of different parts of Europe, but chiefly of Great Britain and France. They were most of them seafaring people, and the origin of the associations about the year 1524 was entirely owing to the jealousy of the Spaniards, who would not allow any other nation to trade or settle in the West Indies, and who pursued the English or French like wild beasts, murdering them wherever they found them. At that time and long afterwards, Spain, in right of her priority of discovery, and of the well-known bull of Pope Alexander VI., considered the whole of the New World as treasure-trove of which she was lawfully and exclusively the mistress. Every

foreigner found among the islands or on the coasts of the vast American continent was treated as a smuggler and robber, and this being the case it is no wonder that seafaring adventurers soon became so, and returned cruelty by cruelty. As early as 1517, when an English ship appeared at St. Domingo to request liberty to trade, the Spaniards fired their cannon at her and drove her away. When this unexpected visit was reported to the Spanish government at home, the minister sent out a sharp reprimand to the governor of St. Domingo because he had not artfully seized the ship instead of driving her away, and so disposed of the English that no one of them should have returned to teach others of their nation the route to the Spanish Indies. But the enterprising nations of Europe were not to be checked by the tyranny of Spain, nor could a papal bull shut the eyes of navigators and make them blind to the improving science of navigation, or to their way across the ocean. The mariners of Europe, moreover, still considered the New World as an Eldorado where gold and treasure were to be had for the fetching, and this made them brave the monstrous cruelties of the Spaniards. In 1526 one Thomas Tyson was sent to the West Indies as factor to some English merchants, and many adventurers soon followed him. The French began to make voyages to Brazil, and the Portuguese and the Dutch successively began to show themselves in numbers in the West Indies. Knowing what they had to expect they were always prepared to fight desperately. From an ingenious phrase, '*se dédommager d'avance*,' used by one of the French flibustiers, it appears they did not always wait to be attacked, but in case of a favourable opportunity became themselves the assailants. To repress these interlopers the Spaniards employed *guarda-costas*, the commanders of which were instructed to massacre all their prisoners. This tended to produce a close alliance, offensive and defensive, among the mariners of all other nations, who in their turn made descents on the coasts, and ravaged the weaker Spanish towns and settlements. A permanent state of hostilities was thus established in the West Indies entirely independent of peace or war at home. 'The Brethren of the Coast' cared not if their respective native countries in the Old World were at peace with Spain; in the New they must of necessity fight the Spaniards or die, or relinquish the benefits which that immense region offered. When not engaged in traffic with the Indians or in predatory excursions against the Spaniards, the principal occupation of these men was hunting wild cattle, of which they made their *boucan*, but they did not begin the latter occupation until several years after their first appearance in the Caribbean seas. At a still later date many of them became logwood cutters in the bay of Campeachy, and as both these occupations soon became very profitable, and trading ships from Europe began to resort to them in numbers for their hides, suet, dried meat, wood, &c., there is good reason for supposing that if the Spaniards had left them in peace they would gradually have settled down into quiet industrious communities. But instead of this, the Spaniards continued to murder them whenever they could surprise them, to burn their log-huts, to hunt them from place to place, and even to kill the shipwrecked mariners who were thrown by misfortune upon their coasts. The effect of all this was, that the buccaneers became as sanguinary as their enemies, increased their numbers, condensed their operations, and soon considered everything Spanish as fair prize, and every Spaniard's life a forfeit to them. Some home-returning flibustiers brought accounts of the barbarities of the Spaniards into Europe, where they soon got into print, were circulated as popular stories, and produced an immense sensation. A Frenchman of the name of Montbars on reading one of these stories conceived such a deadly hatred of the Spaniards that he became a buccaneer, and killed so many of that nation in the West Indies that he obtained the title of 'The Exterminator.' Other men joined the brethren of the coast from less ferocious motives. Raveneau de Lussan took up the trade of buccaneering and robbing because he was in debt, and wished, as every *honest man* should do, to have wherewithal to pay his creditors. By degrees many men of respectable birth joined the associations, on which it was customary for them to drop their family name and assume a new one. Some of the buccaneers were of a religious temperament. A French captain, named Daniel, shot one of his crew in church for behaving irreverently during the celebration of mass. Captain Richard Sawkins, an Englishman, threw the dice overboard on finding them in use on the Sunday; and the first thing Captain John Watling did was to order his robbers to keep holy the Sabbath.

In 1625 the English and French conjointly took possession of the island of St. Christopher, and five years later of Tortuga, which islands became the head-quarters of the buccaneers, who, whenever the countries of which they were natives were at war with Spain, obtained commissions or letters of mark from Europe, and acted as regular privateers in the West Indies and on the Spanish Main. This latter custom gave a colour of legitimacy and honour to their calling, and confounded the notions of right and wrong in their ignorant minds. The governors of the first English colonies in the West Indies, or at least the majority of them, were great rogues, and on condition of sharing spoils with the buccaneers they let them do pretty much as they chose, even when there was no war with Spain.

In 1638 the Spaniards in force surprised Tortuga, while most of the adventurers were absent in Hispaniola hunting cattle, and they massacred all the English and French buccaneers that fell into their hands. The buccaneers soon retook the island, and made it the centre of their

hunting and cruising as before. These singular associations were held together by a very simple code of laws. It is said that every member of it had his chosen and declared chum or comrade, between whom and himself property was held in common while they lived together, and when either of the two died the survivor succeeded to whatever he possessed; but as buccaneers were known at times to bequeath property by will to their friends in Europe, this cannot have been a compulsatory regulation. What, however, was insisted upon by their corporate laws was, that there should be a general participation in certain essentials, among which were enumerated meat for present consumption and other necessaries of life. It has been said that bolts, locks, and all kinds of fastenings were prohibited among them, as implying a doubt of the "honour of their vocation."

In addition to the names already mentioned, Peter of Dieppe, called "Peter the Great," Bartolomeo Portuguez, François L'Olonnais, and Mansvelt were distinguished captains of buccaneers, who made themselves terrible in those seas. But the fame of all these men was eclipsed by Henry Morgan, a Welshman, who succeeded Mansvelt in a sort of general command. He took and plundered the town of Puerto del Principe in Cuba, attacked Puerto Bello, one of the best fortified places in that part of the world, and took and sacked Maracaibo and Gibraltar. Morgan displayed not only the greatest bravery, but many of the higher qualities of a commander; like most of his predecessors, however, he was treacherous, cruel, and bloodthirsty. He was in the habit of torturing his prisoners in order to make them confess where they had concealed their treasures. The boldest and most astonishing of all Henry Morgan's exploits was his forcing his way across the isthmus of Darien from the Atlantic to the Pacific ocean. His object was merely to plunder the rich city of Panama, but his expedition opened the way to the great southern seas, where the buccaneers soon achieved strange exploits, and laid the foundation of much of our geographical knowledge of that ocean. In December, 1670, thirty-seven vessels, having on board about 2000 men, rendezvoused at Cape Tiburon under the enterprising Welshman, whom French and English obeyed with equal alacrity. On the 16th of December he took the island of Santa Catalina, where he left a strong garrison. He next took the strong castle of San Lorenzo, at the mouth of the river Chagre, on the east side of the isthmus of Darien, where out of 314 Spaniards he put 200 to death. He left 500 men in the castle, 150 to take care of his ships, and with the rest, who, after deducting the killed and wounded, amounted to about 1200 men, he began his land march through one of the wildest and most difficult countries, which was then only known to the wild Indians. The fatigues and difficulties they suffered on this march were dreadful. On the tenth day after his departure from San Lorenzo, Morgan, after a desperate combat with the Spaniards, who had 2000 foot and 400 horse, took and plundered the rich city of Panama, which then counted about 7000 houses. Here again his cruelties were abominable. He returned in safety, and loaded with wealth, to San Lorenzo, where he found all his ships undisturbed. Having tricked most of the fleet out of their share of the spoils, he sailed for Jamaica, which was already an English colony. This dexterous ruffian was afterwards knighted by Charles II., and became successively commissioner of the admiralty court in Jamaica, and deputy governor of that island.

In 1673 the Spaniards murdered 300 French flibustiers, who had been shipwrecked at Puerto Rico—a barbarous act which provoked atrocious reprisals.

The short way to the South Seas had been shown by Morgan, and, in 1680, about 330 English buccaneers started from the shores of the Atlantic to cross the Isthmus. The route they pursued varied slightly from that followed by Morgan; but they had men with them more capable of describing what they saw. These were Basil Ringrove, Barty Sharp, William Dampier, and Lionel Wafer, each of whom, in after years, wrote and published an account of his adventures, with a description of the country. Although they formed an alliance with the Darien Indians, who hated the Spaniards, this expedition was not in sufficient force to attack Panama. Two hundred of them, however, having procured a number of small Indian canoes, launched into the bay of Panama, attacked three large armed ships, took two of them, and began cruising in them. These fellows had even some diplomatic skill. Ringrove tells us that the governor of Panama sent to demand of Sawkins their captain, "Why, during a time of peace between England and Spain, Englishmen should come into those seas to commit injury? and from whom they received their commission?" Sawkins replied, "That he and his companions came to assist their friend the king of Darien, who was the rightful lord of Panama, and all the country thereabouts." They then proceeded to capture ships and plunder the towns along the coast, and some of them remained a long time in the South Seas, and made many discoveries.

In 1684 another expedition, in which also the skilful seaman Dampier and the surgeon Wafer were engaged, sailed from Virginia, and, stretching along the whole of South America, doubled Cape Horn and entered the South Seas to plunder the Spaniards. Many of these hardy adventurers explored the Pacific, from the coasts of Chili, Peru, Mexico, and California, to the shores of China, Malacca, and India; and we scarcely know anything of the sort so interesting as Dampier's narrative of this expedition.

In 1670 a solemn treaty of peace, known in diplomacy by the name

of the "Treaty of America," which provided for the entire suppression of the buccaneer warfare, was concluded between Great Britain and Spain; but, as far as the buccaneers were concerned, this was a bit of waste paper, for much the most daring of their achievements took place after the date of the treaty.

The war between Great Britain and France, which followed the accession of William III., in 1688, did much more to relieve the Spaniards from the scourge. The French, without waiting for a declaration of war, attacked the English in the West Indies, where, for some time, the chief belligerents were those ancient allies and comrades, the flibustiers of one nation and the buccaneers of the other, who were now called privateers, and duly commissioned. The bonds of amity were broken; they exercised upon each other some of the cruelties they had exercised in common upon the Spaniards, and they never again confederated in any buccaneer cause. At one time, had they been properly headed, and had conquest, not plunder, been their object, they might, by degrees, have obtained possession of a fair portion of the West Indies—they might perhaps have established an independent state among the islands of the Pacific. Henry Morgan, in fact, at one time entertained this magnificent idea.

The treaty of Ryswick, in 1697, and four years later the accession of a French Bourbon prince to the throne of Spain, brought about the final suppression of the buccaneers. Many of them turned planters or negro drivers, or followed their calling as sailors on board of quiet merchant vessels; but others, who had clippers, or good sailing ships, quitted the West Indies, and went cruising to different parts of the world. For nearly two centuries their distinctive character or function had been the constant waging of war against the Spaniards, and against them alone, and now this was lost for ever.

"After the suppression of the buccaneers," says Captain Burnet, "and partly from their relics, arose a race of pirates of a more desperate cast, so rendered by the increased danger of their occupation, who for a number of years preyed upon the commerce of all nations, till they were hunted down, and, it may be said, exterminated."

(*History of the Buccaneers of America*, by James Burney, F.R.S.; *Lives of Banditti and Robbers*, by C. Mac Farlane; *The Buccaneers of Ameryca*, by an old anonymous author; Dampier's *Voyages;* Lionel Wafer's, Basil Ringrove's, and Barty Sharp's *Narratives;* and, in French, the works of Père Charlevoix.)

BUC'CINA, a military instrument of the shrill horn, or cornet, kind, in use among the ancients, and by some supposed to have been formed of the horn of the bull or goat. According to others it was the shell of the buccinum, a fish. Vegetius ('De Re Militari') says that it was made of brass, and bent in a circle. Blanchinus ('De Instrum. Vet.') also states that it was a metallic instrument; but from the engraving he gives of it, after ancient bas-reliefs, &c., the *buccina* would appear to have been perfectly straight. Sir John Hawkins coincides in opinion with Blanchinus, and copies the form of the instrument from a plate given in the work of the learned Italian; Burnet ('Hist. of Music,) gives an engraving of a curved *buccina* with a very wide mouth. The *buccina* in its primitive state was probably a simple horn, and was subsequently formed of a more durable material. Ovid ('Met.' i. 335) gives an excellent description of the *buccina*.

BUCENTAUR (IL BUCENTO'RO), the state-galley of the republic of Venice, for the name of which many very unsatisfactory derivations have been proposed.

The most elaborate description of this gorgeous vessel with which we are acquainted is that given in the 'Chronica Veneta.' But we doubt not that the reader will gladly be spared a minute account of the carving and gilding with which it was adorned; and a detail of the marine deities, the sirens, the masques, the fruit, the flowers, the shell-work, the medallions, the cornucopias, the allegorical groups, the winged lions, the birds, the zodiacs, the canopies, the virtues, and the liberal arts, which were profusely scattered over it on one of its latest repairs by the skill and taste of 'Giovanni Adami, Doratore Veneto.'

It may be sufficient to state that it was 100 feet by 21 in extreme length and breadth; 168 rowers, four to each oar, were allotted to it from the arsenal, and were disposed in a lower deck; besides these it was manned by a crew of 40 mariners. The upper deck was covered with an awning (*tiemo*) of crimson velvet, beneath which were seated the doge and his goodly company. The doge himself was enthroned near the stern, surrounded with foreign ambassadors, and the senators and great officers of state were disposed on seats running in four rows along the length of the vessel.

The date of the original Bucentaur is not very clearly ascertained; but, like the famous ship at Athens, although in perpetual flux, the galley of the moment, according to Howell, was ever reputed "to be the self-same vessel still, however often put upon the careen and trimmed." "Yet I believe there is not a foot of that timber remaining which it had upon the first dock, having been, as they tell me, so often planked, ribbed, caulked, and pieced." Its use on the feast of Ascension is traced to a victory obtained in the year 1177 by the Doge Sebastiano Ziani over the Emperor Frederic Barbarossa. The Venetians had espoused the cause of Pope Alexander III., who had taken refuge in the Lagune. The doge, with a fleet not mustering half the number of vessels which Pisa, Genoa, and Ancona had placed under the command of the Emperor's son Otho, encountered them off the coast of Istria. After a battle which lasted more than six hours, Otho, with 48 out of his 65 galleys, was taken prisoner, two of his ships having been destroyed. The pope received the conquerors on the Lido, and presenting Ziani with a golden ring addressed him in these words: "Take this ring, and with it take, on my authority, the sea as your subject. Every year, on the return of this happy day, you and your successors shall make known to all posterity that the right of conquest has subjugated the Adriatic to Venice as a spouse to her husband." The Venetians themselves have sometimes claimed an earlier authority for this lordship of the Adriatic; and Foscarini ('Della Letteratura Veneziana,' lib. ii.) finds some trace of it in Dandolo's 'Chronicle' towards the close of the 10th century.

The Bucentaur having been conducted, on the eve of the feast of Ascension, from the arsenal to the piazza, received its splendid passengers. Accompanied by innumerable feluccas and gondolas, it passed on to the mouth of the Lido amid the thunder of artillery. On coming in front of the chapel of the arsenal, the rowers in maritime fashion, saluted an image of the Virgin, and in the meantime the patriarch of Santa Helena, on which island is a convent, awaiting the pomp, was entertained by the monks with a repast of chestnuts and water (*una veramente religiosa, povera colazione*). As soon as the doge appeared in sight, the patriarch embarked with his clerical suite in a small gilded barge (*peatone*) in order to meet the procession, and during his passage he blessed the remainder of the water, which was afterwards thrown into the sea. On issuing from the port of Lido, near the mouth of the harbour, the doge dropped a ring into the bosom of the Adriatic, betrothing her by these words, "We wed thee with this ring in token of our true and perpetual sovereignty." He then returned to the church of San Nicolo di Lido, and having heard a solemn pontifical mass, re-embarked in the Bucentaur and entertained his cortège with a magnificent banquet in the palace.

When the French took Venice, the original Bucentaur was burnt. It was replaced by a model made from drawings and from the recollections of the workmen; this was deposited in the arsenal, but has ceased to be an object of any interest.

BUCHU, or BOOCHO. *Medical Properties of.* These are names given by the Hottentots to the leaves of several species of evergreen shrubs, natives of South Africa, referred by botanists to a species of one of the genera formed out of the old genus Diosma. The several species yielding buchu belong to the genus Barosma, or Baryosma, a more appropriate name than Diosma, many having to Europeans anything but a *divine* fragrance. Three species chiefly are collected. *B. crenata* (Ecklon), *B. crenulata*, Willd., *B. serrata*, Willd. The differences of these are slight, being only of shape and size; they have all one general character, more or less oblong, nearly an inch long by a quarter broad, more or less serrated or crenated at the edges, of a pale or yellowish-green, thickly studded with deeply imbedded transparent glands, filled with volatile oil, and which gives to the dried coriaceous leaves a puckered appearance. On bruising the leaves, the peculiar odour is very perceptible. This is likened to rosemary by those who relish it—to rue, cumin, or cat's urine by those who do not like it. The taste is warm, pungent, mint-like.

The chemical analyses by Cadet de Gassicourt, and in the same year by Brandis, closely correspond. No alkaloid was found, but volatile oil 0·665, gum 21·170, extractive 5·170, chlorophylle 1·100, resin 2·151, lignin 69·744, from Barosma crenata. The bitter extractive has been deemed by Brandis peculiar, and called Diosmin. The volatile oil is yellowish brown, and lighter than water. To it the peculiar odour of buchu is due, as well as much of the medical virtue of the plant.

The Hottentots use a powder obtained by bruising the leaves of several species, and mixed with lard, to besmear their bodies; they distil a kind of brandy (Buchu brandy) from the leaves, along with the dregs of wine. An infusion is also used by them.

The bitter extractive and volatile oil possess tonic, stimulant, and some astringent properties; the organs of secretion feel these, as well as the nervous powers. The digestive organs are strengthened, but the urinary organs feel the influence most. A feeble condition of these with excessive secretion, is much benefited. The skin, in some chronic affections of a gouty or rheumatic origin, is improved. But no disease is so certainly influenced by buchu as the rheumatism which attacks Europeans on their return to a cold climate, after a residence in hot climates, particularly Africa. The spasms of the chest or heart connected with rheumatic irritation of these organs are much relieved by buchu. Asiatic cholera is stated to have yielded to it; but in the bad cases, like everything else, it failed. The best form is infusion with *cold* water, or tincture. The wine is not so good—while *hot* water employed to make an infusion dissipates the volatile oil on which its activity should depend.

BUCKTHORN (*Rhamnus catharticus*, or *Spina cervina*), *Medical uses of.*—The berries contain a peculiar extractive, a colouring principle, acetic acid, gum, and sugar, which is of the nature of grape sugar. The properties are purgative, and the action is attended with much sickness, griping, and thirst. All the forms of exhibition are objectionable, but particularly the berries, either fresh or dried: yet this acrid and almost poisonous article is retained in practice, and is a common domestic medicine, especially for young children, the most unsuitable of all for its employment.

The berries of several different shrubs are said to be substituted for those of the *R. catharticus;* a circumstance which is fortunate, if any more harmless are made to replace them. Buckthorn berries are themselves used to adulterate cubebs.

BUCK-WHEAT (Poly'gonum fagopy'rum) is said to be found wild in Persia. The cultivation of it, according to some authorities, was introduced into Europe by the crusaders; according to others, the Moors introduced it into Spain from Africa; and hence it has in France the name *blé sarrasin.* The name of buck-wheat is a corruption of the German buch-weizen, which signifies beech-wheat, from the resemblance of the seed to that of the beech-tree. It is called wheat because, when ground, it produces a fine farina, which resembles that of wheat in appearance. The botanical name of the genus, Polygonum, is taken from the angular form of the seed, and the specific name, fagopyrum, from its resemblance to beech-mast. Buck-wheat grows with a strong herbaceous, cylindrical, and branching stem of a reddish colour, about 2 feet high. The leaves, which are ivy-shaped, are placed alternately on the stems. The flowers grow in bunches at the end of the branches, and are succeeded by black angular seeds, formed of four triangles, being thus nearly regular tetrahedrons. The plant is an annual, and the flowers appear very soon after it is out of the ground. They continue to blow and bear seed in succession till the frost destroys the plant. Being a native of a warm climate, the smallest appearance of frost in spring, while the plant is tender, entirely destroys it. Hence it is never sown in northern climates till all danger of frost is over, which in many parts of England is not till the middle of May; but its growth is so rapid, that it may be reaped in September, at which time the principal part of the blossoms will have ripened their seeds. No advantage would be gained by leaving it longer on the ground, for even if the frost did not kill the whole plant, the earliest ripened seeds would be shed and lost; and the last blossoms would not produce perfect seeds.

The cultivation of buck-wheat has never been very extensive in the variable climate of Britain. It is not so well adapted to cold wet soils as to warm sands; nor is it so certain a crop as oats or barley on lands which are suited to the growth of these grains. For countries where there are very poor light lands with a hot dry climate, unfavourable to the growth of oats, and not rich enough for barley, buck-wheat is a great resource; and without it, many tracts of poor land would scarcely be capable of supporting a population. As a principal crop, therefore, it is confined to some parts of the south of France and other countries similar in soil and situation. As a secondary and occasional crop, it often occurs in Switzerland, Germany, and especially in Flanders, where it enters as a regular part of their varied and complicated rotations. Under particular circumstances, it might be introduced with advantage into many parts of England where it is now unknown. The only counties in which it is cultivated to a moderate extent at present are Norfolk and Suffolk, where it is called *brank.* If a small patch of buck-wheat is occasionally met with elsewhere, it is, in general, mainly for the sake of encouraging game, particularly pheasants, which are extremely fond of it.

When buck-wheat is cultivated as a regular part of a rotation, it is generally after the land has been considerably exhausted by former grain crops, and manure cannot be had in sufficient abundance to recruit it. It will then produce a better return than oats, and leave the land in a better state, especially in warm and dry seasons. On richer and better soils it may be occasionally a good substitute for barley, when the land cannot be properly cleaned and tilled sufficiently early in spring; for it allows a full month more to prepare the ground; and in this one month, if it be hot and dry, a good tillage may produce nearly all the advantage of a summer fallow. Buck-wheat, on good land, will produce nearly as valuable a crop as barley, though it is certainly more precarious; the seeds sown with it will probably produce more grass or clover than they would if sown with barley; for buck-wheat, sown thin, as it always should be in this case, does not choke the grass, but shelters it from the scorching rays of the sun; and as it draws the land less than any other grain, it leaves it in better heart for the clover. It has been strongly recommended to be sown on good, clean, light land, after winter tares have been either fed off by sheep or cut green for horses. By this means, the root weeds, which had been smothered by the tares and ploughed up immediately after the tares were off, will not have time to spring up again; the rapid growth and the shade of the buck-wheat effectually keep them down, and prevent the annual weeds from going to seed. Thus a crop is obtained between the tares and the wheat, and the land is kept perfectly clean. This is mentioned by Arthur Young, in the 'Survey of Suffolk,' as a successful practice, and strongly recommended. Buck-wheat may be ploughed into the ground in a green state. For this purpose, it is sown tolerably thick, and when the plant is in its greatest vigour and in full blossom, a roller is passed over the crop to lay it level with the ground. The plough, with the addition of a skim coulter, turns it neatly into the furrows and completely buries it. It soon decays from its own moisture, and the decomposed parts being incorporated with the soil greatly add to its fertility.

On poor sandy reclaimed soils, especially if they are trenched to a considerable depth, buck-wheat may be sown with great advantage for the purpose of being ploughed in as a preparation for the first crop of turnips. The turnips fed off by sheep penned on them will enrich and consolidate the ground sufficiently for a crop of corn or clover and grass seeds. A bushel and a half, or at most two bushels, is an ample allowance of seed for an acre; the cost of it is at most 8*s.* or 10*s.* When buck-wheat is ploughed in for manure, care must be taken to consolidate the surface of the land, if it be light, by rolling or other means, for the decaying stems leave it very loose and hollow; but if the soil is tenacious, the air which is let in mellows it and makes it crumble, which is a great advantage. Provided the soil be stirred to a considerable depth, so that the roots of the buck-wheat may strike deep in search of nourishment, however poor or light it may be, or however dry the weather, it will produce a good crop of seed. It only wants a few showers at first, and at the time when the seeds begin to be formed. It continues to put forth blossoms for a long time, and if the first-formed seeds should not be so full as might be wished, the latter may probably make up for it. The careful husbandman must examine the plants at different periods, and reap when he finds the greatest quantity of ripe and full seeds. It is not possible by any management to have all the flowers come to seed in perfection; but under favourable circumstances from four to five quarters of good seed may be obtained from an acre of well-tilled land.

Manure is seldom or never laid upon land upon which buck-wheat is sown, because even where manure is abundant it is reserved for other crops supposed to require it more. It is asserted by many that manure makes the buck-wheat run to haulm and diminishes the crop of seed. That this may be the case with injudicious additions of dung, we are not inclined to dispute; but if the land be tilled to a sufficient depth, if the manure be well prepared and intimately mixed with the soil, and if the buck-wheat be sown thin in proportion to the richness of the land, we have no doubt that it will not only grow high and strong and blossom well, but also give an abundant crop of seeds. The reason why crops run to straw and are deficient in corn, when the land is moist and has been highly manured, is, that the manure ploughed in and covered only with a few inches of soil excites an extraordinary vegetation in the young green plant, which makes it shoot out a strong vigorous stem; but by the time of flowering, the dry weather has exhausted the rich moisture of the manure, and the plant, pushing its roots downwards in search of food, finds a less fertile soil below, out of which it cannot draw the materials to form a full and plump seed. But when a soil is naturally rich, or artificially made so to a considerable depth, a strong and high stem is generally the forerunner of a great bulk of seed, as is often seen in those oats which are scattered thinly among winter tares, the straws of which are like reeds, and the grain, if allowed to ripen, is always both heavy and abundant.

Buck-wheat is sometimes cut in its tender state for soiling cattle. It is said to increase the milk of cows greatly: it is also occasionally pastured by sheep. There is a diversity of opinion on its qualities, some speaking highly of it, and others asserting, and with some appearance of truth, that it is not eaten by sheep or cattle in preference to any other plant, and that it has a stupifying and intoxicating effect when eaten in any great quantity. Upon the whole, we are inclined to think that its value is chiefly as an addition to the variety of plants cultivated for their seeds, and as a cheap vegetable manure.

Buck-wheat may be reaped with the sickle or mown with the scythe, or it may be pulled up by the roots. The latter method is recommended by some, as less likely to shed the seed when fully ripe. In dry weather it is recommended to cut or pull it very early in the morning or late at night, when the dew is on it, and not to move it much in the day. It may be tied up in sheaves, or put into small heaps, as is done with peas. In either case birds must be carefully scared away, or they will take a large share of the produce.

Buck-wheat as a grain may be given to horses instead of oats, or mixed with them. No grain seems so eagerly eaten by poultry, or makes them lay eggs so soon and so abundantly. The meal, when it is ground, is excellent for fattening cattle or pigs. The flour is fine and white, but from a deficiency in gluten does not make good fermented bread. It serves well, however, for pastry and cakes: crumpets made of buck-wheat flour eaten with butter are a favourite dainty for children in Holland. A hasty pudding is also made of the flour, with water or milk, and eaten with butter or sugar.

On a careful consideration of the reasons for and against a more general cultivation of buck-wheat in our northern climates, it appears to have certain qualities which make it well worth attention. As it belongs to a different natural family in the vegetable kingdom, it is probable that it may be a useful change when the land has been too long cropped with gramineous plants. It may impart to the soil, or abstract from it, some principles by which its power of producing other crops may be increased. This can only be learned with certainty by repeated experiments; but some considerable effect may be expected from the powerful salts which we know are found in the ashes. Its value as a manure is indisputable; the only thing required is an accurate calculation of the comparative expense of its application with that of bones or any other purchased manure, taking quality and quantity into consideration. A few experiments on an extensive scale, and made with that attention to minute circumstances which is so often neglected in agricultural experiments, and repeated with perseverance, might place the cultivation of buck-wheat in a new point of view.

An analysis by Horsford, given in Morton's 'Cyclopædia of Agriculture,' gives the following as the composition of the seed :—

Organic matter fitted for the formation of flesh		8·58
Matter fitted for respiration, &c.	Starch	51·91
	Fibre	23·12
Ashes		2·20
Water		14·19
		100·

The ash, as analysed by Sprengel, contains

Potash	10·27
Lime	21·98
Magnesia	40·34
Alumina (?)	0·81
Silica	4·37
Peroxide of iron	0·47
Peroxide of manganese	1·00
Chloride of sodium	4·90
Sulphuric acid	6·77
Phosphoric acid	9·00
	100·00

These results will no doubt vary according to the soil in which the plants have grown. The potash is so abundant that it has been suggested as a profitable use of the haulm to burn it for the purpose of obtaining this useful salt. This abstraction from the soil, or its addition to it in the shape of manure, must produce a considerable effect on the fertility. There is another species of buck-wheat mentioned by some authors as superior to the common, and more deserving of culture in northern climates; it is called the *Polygonum Tartaricum*. Yvart, in his excellent article, 'Succession de Culture,' in the 'Cours Complet d'Agriculture,' Paris, 1820, speaks highly of the Tartarian buck-wheat. It is yellower in the colour, and bears a smaller seed, but is much hardier. Its stubble will remain alive during the winter, grow out in spring, and produce a second crop the next year if let alone; but this does not seem any great advantage, as the second crop is very apt to be overrun with weeds. Yvart mentions a crop grown in the Department de l'Isère which appears extraordinary: 12 measures sown produced 1296 measures, or more than a hundredfold, in a very dry season. Another gentleman obtained 80 for one. After all, experiments reported in this way teach very little: a return so many fold the seed may appear large in consequence of very thin seeding, although it is not absolutely a good crop per acre; and notwithstanding these accounts, Thaer, who has repeatedly tried it, says that "its produce in a field is so insignificant that he cannot join in its praise." (vol. iv. s. 162). Perhaps the experiments made in a rich spot in a garden have given results which multiplied produce the above extraordinary returns. Agricultural experiments are unfortunately often made in this way, and consequently give very fallacious results.

BUCO'LICS, from the Greek Βουκολικά (Bucólica), signifying literally, "poems on the tending of oxen or herds generally." Bucolics are a species of poetry, or rather an exercise in verse, in which the interlocutors are shepherds, husbandmen, and their "mistresses." Great antiquity is claimed for its invention. Some have babbled about the Golden Age and Arcadia; and some have attributed it to the Sicilians, perhaps for no better reason than because their island exhibits abundance of pastoral scenery. Others have said, that on the invasion of Greece by the Persians, when the festivals of Diana were suspended, the country people thronged the temples, and sang hymns to that goddess concerning their rural occupations, which thence were called Bucolics. There has also been equal difference about the name of the inventor, and Diomus and Daphnis, whoever they may be, Stesichorus and Theocritus, has each had his supporters; for the critics have forgotten that it is one thing to sing as shepherds do while tending their flocks, and quite another thing to sing as poets do when relating the life of shepherds.

Theocritus, Moschus, and Bion, have written Bucolics in Greek, and Virgil has copied them in his Eclogues. Calpurnius, a later Latin poet, has shown us how tame and insipid Bucolic poetry may be. Such beauties as these compositions contain, are chiefly comprised in delicacy of expression and refinement of language. Bucolic poetry has been little cultivated by the moderns; the French have converted it into mawkish gallantry; and the rank which it maintains in England may be estimated, when it is stated that Cunningham and Shenstone have been its principal ornaments. Those who deem this subject worthy of further investigation may look to the 'Poetics of Scaliger,' i. 4; 'Salmasius on Solinus,' pp. 851, 867; and the dissertation prefixed by Heyne to his edition of the Eclogues of Virgil.

BUDDHA; BUDDHISM. Among the religions of Asia, that of Buddha is one of the most remarkable, partly for the peculiar character of its doctrine, and partly on account of the vast number of its followers. From India Proper, the country which gave it birth, nearly every trace of Buddhism has now disappeared; but it has become the religion of the great majority of the inhabitants of the high table-land to the north of the Himâlaya, as far as the boundary of Siberia, and it is the prevailing creed of China, of the Peninsula of India beyond the Ganges, of Ceylon, and several islands of the Indian archipelago, and of the empire of Japan. According to an estimate given by Berghaus

('Physikalischer Atlas,' Abth. Anthropographie, No. 4), there are now upon the globe—Christians of all denominations, 390 millions; Jews, 4 millions; Mohammedans, 200 millions; followers of the Brahmaic religion, 170 millions; Buddhists, 397 millions; and heathens, 111 millions.

Though much had been written upon Buddhism, a critical investigation of its origin, its system of doctrines, and the history of its diffusion among so large a portion of mankind, was still a desideratum. Hardly any of the original authentic documents of the sect, which were written in Sanskrit, had been fully examined, and the information which we possessed respecting its dogmas, was almost exclusively derived from sources of a secondary rank. But several distinguished scholars, among whom we may mention Isaac Jacob Schmidt, of St. Petersburg, Alexander Csoma de Körös, at Calcutta, Brian Houghton Hodgson, in Nepâl, and George Turnour, in Ceylon, severally engaged in inquiries. At length in 1837, Mr. Hodgson having collected upwards of eighty valuable Sanskrit documents on the subject, generously sent them to Paris, where M. Eugène Burnouf went to work indefatigably upon them, and in 1844 published his 'Introduction à l'Histoire du Buddhisme Indien.' He compared his original documents with their translations in four or five other languages, and developed the dogmas and the history of this religion, which forms the faith of so large a portion of the population of the world. He continued his labours till his death in 1852, immediately after which was published what he had left fit for publication, though in some degree fragmentary: 'Le Lotus de la bonne Loi, traduit du Sanscrit, accompagné d'un Commentaire, et de vingt-un Mémoires relatifs au Buddhisme.' These two works form an admirable monument of philological genius united to a sound philosophy.

The origin of Buddhism is involved in much obscurity. Doubts have been raised whether Buddhism is of Indian growth, or whether it was introduced from abroad; the relative antiquity of Buddhism and the religion of the Brahminical Hindus, who follow the doctrines of the Vedas, has been matter of dispute; and the greatest discrepancy prevails with respect to the epoch which, according to various authorities, should be assigned to the founder of the sect. It is somewhat remarkable that, after having been described chiefly from those portions of the globe over which Buddhism now prevails, the most reliable accounts of the genuine system should have been at last found in the language in which it was first developed.

Among those who, contrary to the opinion generally received by the Buddhists themselves, have suspected that the sect did not originate in India, Sir William Jones must be mentioned. The curled or woolly appearance of the hair on the head of the statues of Buddha, many of which are sculptured in a black kind of limestone, combined with other circumstances, led him to form an opinion, that the inhabitants of India, who occupied the country previous to its invasion by the Brahmanic tribes from the north, were of African descent, and that in the sculptured representations of their legislator some of the characteristic appearances of the negro race had been preserved. ('Asiatic Res.' vol. i. p. 427.) But the foundation on which this opinion rests, is in some degree shaken by the fact, that images of Buddha are as frequently seen in white or gray as in black stone; while on the contrary, statues of Krishna, Sûrya, Ganêsa, and other deities of the various Brahmanical sects, with whom the presumed reason of the Buddhists for giving preference to black could have no weight, are nevertheless frequently seen of that colour. Another argument against the supposed African origin of Buddha may be deduced from the enumeration of his *lakshanas* and *vyanjanas*, or points of beauty and peculiar personal appearances, which are so familiar to Buddhists everywhere, that this circumstance alone seems to warrant their antiquity, and to entitle them to at least equal credit in our inquiry into the extant sculptured images of the sage. The original Sanskrit text of the thirty-two *lakshanas* or "characteristics," and of the eighty *vyanjanas* or "peculiar signs" of Buddha, were published in the appendix to an interesting paper by Mr. Hodgson in the 'Journal of the Royal Asiatic Society,' vol. ii. p. 314, &c. Among the former we observe one (No. 14, *suvarna-varnatâ*) which describes Buddha as being of a gold-coloured complexion; and among the later there is one (No. 59, *tunga-nâsikatâ*), according to which he had a prominent (aquiline ?) nose. Both these epithets are utterly inapplicable to an individual of the negro race. (See Abel Rémusat, 'Mélanges Asiatiques,' Paris, 1825, 8vo, vol. i. p. 100, &c.) With reference to the curly hair of the statues of Buddha, we may mention that, according to a remark of Colonel Mackenzie ('As. Res.' ix. p. 249), the *Mahâvratas*, a class of *Jaina* ascetics who are not allowed to shave the head with razors, employ their disciples to pull out the hair by the roots; and to the effects of this operation they attribute the appearance on the heads of the images of their *Gurus* or saints, which Europeans suppose to represent curly or woolly hair. It has been suggested by some, that the curls on the head of the images of Buddha might be accounted for in a similar manner. In the list of personal characteristics of Buddha, however, no less than six terms descriptive of his hair are enumerated (*vyanjanas*, Nos. 72—78), which, though some are not very clear in themselves, seem to attach a notion of beauty to its peculiar appearance: this could hardly be the case if the curls had been considered as morbid, and produced by a violent extirpation of the hair. The answer which Mr. Hodgson obtained from a priest in Nepâl to an inquiry respecting the reason of Buddha being represented

with curled locks was to this effect, that it was considered a point of beauty; still the notion is, as Mr. Hodgson observes, an odd one for a sect which insists on tonsure.

The Buddhists themselves, however much they may disagree as to the period at which the founder of their religion lived, make no pretensions to a very high antiquity of their sect, but admit on every occasion the priority of the Brahmanic creed.

The Buddhists of Ceylon place the period of Sàkya, or Buddha, at the 6th century before the Christian era, which date is confirmed by the testimony of the Buddhistic writings, by inscriptions and by medals. The Chinese Buddhists claim a far higher antiquity, but this claim is rejected by M. Eugène Burnouf, and is contradicted by the Sanskrit texts: that it cannot be much later is proved by the writings of classical authors, to whom they were known as Sarmanes, Samaneans (a corruption of the Sanskrit *samana*, stable, unalterable), or Gymnosophists, though the Brahmanic ascetics appear to have been confounded with them under the latter name. 'The Mahawansa,' a chronicle in the Pali tongue, which has been translated by Mr. Edw. Upham in three volumes in 1833, gives a series of continuous dates, which, dating from the death of the last Buddha (Sàkya), is no longer embarrassed by the indefinite system of fictions peculiar to the Brahmanic works.

According to the concurrent traditions of the Buddhists, in various parts of Asia, the founder of the sect was the son of Suddhôdana, king of Magadha in South Behar, and Mâyâ. His name is said to have been Sarvârthasiddha; but he bore several designations, either as Sàkya or Buddha, among which are the following: Muní, Sastri, Munîndra, Vinayara, Samanta, Bhadra, Dharma Rájá, Sugata; and his titles are, Sàkyamuni, Sàkyasingha, Sarvartha-siddha, Sud'hodhani, Gautama, Arcaband'hu, or kinsman of the sun; Mâyâ, or child of Mâyâ (delusion), or Mâyâdevisuta. The title of Buddha, or "the sage," does not seem to have been given to him till after he had attained eminent sanctity as a teacher of religion. Several of these names appear under somewhat modified shapes in the languages of the various Buddhist nations; thus Sàkyamuni has, by the Mongols, been corrupted into Shigimuni; Gautama, preceded by the honorific Sanskrit title of Sramana, "the ascetic," has, in Siamese, become Sommonacodom; the Chinese have converted Magadha into Moki-to, under which name they comprehend India generally; Buddha they have corrupted into Fo-ta and Fo; and Suddhôdana, like many other Sanskrit compound names, they have analysed and translated into their own language by Zing-fan-wang, that is, "the eater of pure food."

The circumstances of the life of Buddha, which we find recorded, are only few. Conformably to the prevailing usage of the country, the infant was, a few days after his birth, presented before the image of a deity, which is said to have inclined its head when the child was brought near its shrine, as a presage of his future greatness. In his tenth year the boy was placed under the guidance of a spiritual instructor, whose name, according to a Mongol account of the life of Buddha, was Bah-Burenu Bakshi. He soon developed mental faculties of the first order, and became equally distinguished by the uncommon beauty of his person. At the age of 20 years he married a noble virgin called Yasôdharâ Dêvî in the Ceylonese account of his life. He had by her two children, a son (whom the Mongols call Racholi; the Ceylonese, Rahula Kumareyo) and a daughter. At this period of his life it is related that earnest meditations concerning the depravity and misery of mankind began to engage his mind, and he conceived a plan of retiring from human society and becoming a hermit. His father endeavoured in vain to frustrate this design; Buddha escaped the vigilance of the guards appointed to watch him, and took his abode on the banks of a river, named in the Mongol history Arnasara or Narasara, in the kingdom of Udipa. Here he lived during six years, undisturbed in his devout contemplations. At the expiration of this period he came forward at Warnashi (Varanasi, that is, Benares) as a religious teacher. It is said that, by some who heard him, doubts were at first entertained as to the soundness of his mind; but his doctrines soon gained credit, and were propagated so rapidly that Buddha himself lived to see them spread all over India. He died in his 80th year. (Klaproth's 'Asia Polyglotta,' p. 122, &c.; I. J. Schmidt's 'Geschichte der Ost-Mongolen,' pp. 312, 313.)

To become a disciple of Buddha it was sufficient to declare a belief in him; but the neophyte had to shave his hair, to wear a cloak made of yellow rags, and to study under an older believer. No person could be admitted to the society by a single member: it must be done in general assembly. This assembly, of which Sàkya was the chief, consisted of male and female mendicants, who bound themselves to perpetual chastity and poverty, and of believers who had not adopted any ascetic rule. From among the ascetics, however, were chosen the elders, according to their merit and seniority. The highest rank was that of the aryas, or those who had comprehended the four axioms which are the foundation of the Buddhist doctrine: that is, 1, that there exists pain; 2, that all that is born in this world suffers pain; 3, that it is necessary to liberate ourselves from it; and, 4, that knowledge alone offers the means of this deliverance.

Transmigration, attaching rewards to good acts and punishments to bad, leads to the notion of expiation, which ought to be effected by the performance of good actions; but the only form which it receives in practice is confession, and this was instituted by Sàkya himself.

The worship of Buddhism is extremely simple; the ceremonies consist in offering flowers and perfume, accompanied with instrumental music, hymns, and prayers. There were no bloody sacrifices, and the worship is in fact not addressed to one god, or a number of gods, but to a figure of Sàkyamuni, and the buildings enshrining a part of his bones. An image and relics, this is the whole of the worship of the Buddhists. Hence the legends dwell so much on the personal beauty of Sàkya, ascribing to him 32 characteristics of beauty, and 80 secondary signs, and hence also Buddha is always represented as a man sitting and meditating, and not with the exaggerated attributes of the Brahmanical deities. This system has undergone considerable modifications. Other images have been introduced, such as the five dhyáni Buddhas, of which drawings have been published by Mr. Hodgson, but which he considers as mere personifications of the phenomena of the physical world: they on the whole, however, maintain the form of a man who meditates or teaches.

The relics consist of the ashes of the body of Sàkya, which, after the body was burnt, were collected into eight metal cylinders, and buried under the like number of chaitayas. The uninterrupted tradition of 17 centuries confirms the destination of these topes, or columnar erections, of which many have been opened within the last few years, by General Ventura, Major Cunningham, Lieut. Maisey, and others.

The books now extant form three classes: the Sutrapitaka, or discourses of Buddha; the Vinayapitaka, or the discipline; and the Abhidharmmapitaka, or the manifested laws or metaphysics. The whole are termed Tripitaka. This division is also recognised among the Chinese, who name them sacred books, precepts, and discourses.

The Sùtras are dialogues in which Sàkya is the teacher. Sàkya always commences a Sùtra with the formula, "Lo, what I have learnt." They were evidently written when the system of castes prevailed in India, and which were then Brahmans, Ksattriyas, Vaisayas, Sudras, and Chandalas, with some subdivisions; the names of the castes are continually quoted.

A second class of the Nepâlese works are the Avedanas, which are legends; they are later and of various dates.

The Indian books, Sanskrit and Pali, show us in Buddha a religious reformer, desirous above everything to change the manners of his contemporaries. An infinite charity,—the desire of imparting to others the satisfaction enjoyed under the rule of an excellent doctrine,—giving a strong impulse to proselytism among all ranks and from all castes,—the admission to the priesthood of persons from classes the most despised, whenever they had rendered themselves worthy of this supreme honour by their virtue,—in one word, equality before God, such were the characters of the doctrine presented by Sàkya. M. Eugène Burnouf ('Introduction à l'Histoire du Buddhisme Indien') relates a response of the great reformer, which at once enables us to comprehend the principle of the new religion. The Brahmans had been ridiculing him on account of a new disciple, whom he had converted when sunk to the lowest degree of abasement and misery. "My law," he said, "is a law of grace for all; and what is this but a law of grace for all? It is a law under which the most miserable mendicants may make themselves religious." "Remarkable words," says M. Burnouf, "of which the spirit has propagated Buddhism, and which was still vivid at Ceylon even at the beginning of the present century, when a religious, disgraced by the king for preaching to the miserable and despised caste of Rhodias, answered nearly the same as Buddha himself: Religion ought to be the common good of all."

The Buddish compositions are not written in the rich but simple style of the Mahábhárat, but yet not in the monotonous idiom of the Purânas, and the plan is somewhat inartificial. In the Sùtras Buddha is usually placed in some town of India, where he is represented as surrounded by an assembly of religious hearers, sometimes with the addition of a number of gods, to whom he preaches his doctrines, which, however, contain nothing of the mythological machinery subsequently introduced. None are mentioned but Buddhas, of whom Sàkya was the last, and all are men like himself, the sons of Brahmans, or kings. He, however, claimed a previous existence, and occasionally confirms his doctrine by relating what happened to himself, or his disciples, in a former life.

Sàkya admits and names a number of the brahmanical gods, but deems their power inferior to that of Buddha; and he taught that the Buddha, a supreme intelligence, was involved in an always moving progress of transmigration, through animals, criminals, men, and gods; that all the visible world is in perpetual change; that death succeeds life and life death; but by the practice of six transcendant perfections —alms, morals, science, energy, patience, and charity,—a man might hope to obtain rest from this continued change, and arrive at the state of Nirvâna, deliverance or annihilation.

The means of conversion used by Sàkya were preaching, with reference to his own holy life, the possession of knowledge, and the performance of miracles.

To diffuse his doctrines, Sàkya employed preaching, a new means in India (absolutely unknown to Brahmanism, which then reigned paramount in that country), which perfectly suited the popular character of his instruction, and which was the foundation of his proselytism. Religious truth was no longer, as with the Brahmans, the exclusive possession of privileged castes, but became the patrimony of all who were willing to acquire it. It was this mode of propagation that so

rapidly multiplied his adherents, the *sectateurs* of the reformer, and which at the same time rendered Buddhism an object of bitter enmity to the Brahmans, whose religious system, founded principally on the existence and perpetuity of a sacerdotal race, it ruined. Buddhism, however, did not always abolish caste where it prevailed; it was accepted, but Buddhism thus brought together by the common band of charity those who had been until then separated by insurmountable barriers. It is thus that these divisions subsist even yet in Ceylon, of which the population was among the earliest to embrace Buddhism. But if this religion does not abolish caste, it does not consecrate it like the Brahmans; it is not imposed in any way by their institutions; and hence, in those countries where castes were unknown, as Tibet, Siam, Birma, &c., they have not been introduced with these doctrines, which show themselves, consequently, in a form in some degree democratic.

Buddhism distinguishes itself from Brahmanism not only by a character that we may term democratic, but still more by the extreme simplicity of its religious doctrine, and by the almost complete absence of dogmas. All its teaching is essentially moral, and this morality rests upon an imitation of Buddha; that is to say, upon the religious life represented as the ideal for a man in this world. Imitate Buddha, conform yourself as much as possible to this type of perfection,—such is the supreme precept of the religion; for the rest, this religious and ascetic life is not exclusively reserved for the men. Buddhism has convents for females, in which similar rules are imposed and observed. It has, however, one point of resemblance with Brahmanism—the syllabic designation of the chief deity—Om, or Awm—is a word of reverence with both sects.

It is by the practice of these virtues, and by faith in Buddha, that man arrives at Nirvâna; that is to say, to deliverance—to supreme happiness. But what is this supreme happiness? According to some it is the absorption of the individual life into the Deity; according to others it is annihilation; and lastly, according to the Tibetans, it is the death of the body, the deliverance from physical sufferings, or rather the enfranchisement from the law of transmigration. Although these explanations vary, it is easy to recognise in them that the idea of the Nirvâna is that of repose, the highest notion of happiness in India. The aim of Buddhism is, then, to conduct man to happiness by the exercise of virtue.

One of the means is confession. Confession leads to casuistry; that is to say, the classification of different species of faults, and this science occupies a large place in the teaching of the religion.

The dogmas are simple, at least in ancient Buddhism. It is sufficient to believe that Buddha was a man of a supreme degree of intelligence and of virtue, who is proposed to every one as a model and rule of life.

Latterly, Buddhism lost much of its moral tendency, and mythological conceptions, borrowed from Brahmanism, were mixed up with it. The books named *Tantras* show us in the highest degree the confusion of these two rival faiths. We see the worship of Sàkya, the Dhyani Buddhas, or four stages of contemplation, and of Adibuddha, mixed up with the worship of Siva and the female divinities of the Sivaites. It is, in effect, from the theory of the supreme Buddha with the superhuman Buddhas and Bodhisâttwas, that the primitive monotheism of Buddhism has ended by approaching to a veritable polytheism. Although Buddha may be the name by which Sàkya is designated, it does not essentially belong to that personage. The word Buddha does not properly mean a man, it is rather a title by which some of the privileged ascetics are called. The Buddhists name those Boddhisâttwas who, by the practice of all the virtues and the exercise of meditation, are ripe for the supreme state of Buddha perfectly accomplished. He who wishes to attain to this state cannot do it of his own will; he must, during several stages of transmigration, have merited the favour of one or more of the ancient and gigantic Buddhas, in whose reality most Buddhists believe; and it is only when in possession of their favour, in one of those heavenly places above the earth, that he awaits, under the title of Boddhi-vattu, the moment of his coming into the world. Descended upon earth, he is not yet Buddhas; it is not till he has undergone all the proofs, accomplished the most exalted duties, penetrated the most sublime truths by sciences, that he becomes Buddhas. Then he has the power of delivering men from the conditions of transmigration, by teaching them charity, and showing them that those who practise the duties of morality in this life, and strive to attain scientific knowledge, may one day attain the supreme state of Buddha. At length, having taught the law, he enters into the Nirvâna. Sàkya is but one of these mysterious Buddhas.

The Buddhistic doctrine comprehends a very abstruse metaphysical system, in which re-appear, under essentially Indian forms, speculations on the absolute, on the first cause of the universe, and on the essence of things. All these problems are treated of in the Abhidarma (one of the Buddhistic books) just as they are in modern European books, with identical solutions occasionally, but differing according to the nature of the mind producing them.

The earliest allusion to the sect of Buddha in any western writer has been supposed to occur in Herodotus (iii. c. 100; Korai, 'Prodr. Hell. Bibl.,' p. 271), who says of certain Indians, that they kill no animals, and live on the vegetable products spontaneously produced by the soil. Nicolaus Damascenus may, however, possibly allude to the very words of Herodotus, in a detached passage where he speaks of an abstemious

sect called Aritoni (Ἀρίτονοι), which name seems to be the Sanskrit Arhat, or Arhata, a very common designation of the Jaina sect, who are even more distinguished than the Buddhas by their extreme tenderness for animal life. Strabo (xv. c. 1, p. 712, ed. Casaub.), on the authority of Megasthenes, states that there are two classes of philosophers among the Hindus—the Brachmanes and Garmanes; and from the account which he gives of the latter, who are by Clemens of Alexandria ('Strom.,' i. p. 305) more correctly called Sarmanes, it is clear that by them the Buddhists are to be understood. The name Sarmanes appears to be the Sanskrit word Sramana, "a religious mendicant, an ascetic." A Buddha beggar is thus designated by a Brahman in the 'Mrichhakati,' a Sanskrit drama, supposed by Mr. Wilson to have been written either one century before or two centuries after our era (act viii. p. 212, ed. Calcutt.). We recognise the same word under a slightly modified shape in the first component part of the name of the Indian philosopher Zarmanos Chanes (Ζάρμανος Χάνης, written in some manuscripts Ζαρμανοχήγας, Ζάρμανος Χήγας, Ζαρμανοχανης; and in Dion Cass., liv. c. 9, Ζάρμαρος, Σάρμαρος, or Ζάμαρκος), who came to Europe with an embassy from King Porus to Augustus, and voluntarily burnt himself at Athens. (Strabo, xv. c. i. pp. 719, 720.)

Two very remarkable passages on the various sects prevailing in India occur in Clemens of Alexandria. In the first passage ('Strom.,' lib. i. p. 359, ed. Potter) he says that there are two classes of philosophers in India, the Sarmanæ and the Brachmanæ. "Among the Sarmanes, those called Hylobii (ὑλόβιοι, Mountagu thinks, should be read instead of ἀλλόβιοι) do not dwell in towns or houses; they are clad with the bark of trees, eat acorns, and drink water with their hands; they know not marriage, nor procreation of children." He then proceeds to say that "there are likewise among the Indians persons obeying the precepts of Boutta (Βούττα), whom they venerate like a god, on account of his extreme sanctity." Here the followers of Boutta (Buddha) are clearly distinguished from both the Brachmanæ and Sarmanæ. In the second passage (p. 539, ed. Potter), Clemens speaks of a sect whom he calls Semnoi (another corruption of the Sanskrit name Sramana?), "they go naked all their lives; they make it a point always to speak the truth; and they inquire into the future. They worship a certain pyramid, beneath which they believe the bones of some god to be deposited. Neither the Gymnosophistæ nor the Semnoi have any intercourse with women, for they deem this contrary to nature and to law, and for that reason they adhere to chastity. There are also females of this class (Σεμναὶ) who live in perpetual virginity." The pyramids here spoken of are evidently the dagobas of the modern Buddhists.

The statements respecting the religion of India and China given by the two Arabian travellers who visited these countries in the 9th century (Renaudot, 'Anciennes Relations des Indes et de la Chine,' &c., Paris, 1718, 8vo) are too vague to enable us in every instance to distinguish whether the "pagans," of whom they speak, were Buddhas or not. In the report of the first traveller (l. c. p. 3) we meet with an allusion to the impression of a foot on Adam's Peak in the Island of Ceylon, a spot known to Ebn Batuta (Lee's translation, p. 189) as a place of pilgrimage, which it has continued to be till the present day with the Ceylonese Buddhists. The second traveller, in speaking of the natives of India, calls their priests Brahmans (l. c. p. 107), and in the account which he gives of their ascetics, and of their religious institutions generally, nothing occurs that would, in our opinion, admit of an application to the Buddhas. These statements, though not very explicit, are yet interesting, as they seem to attest the expulsion of the Buddhists from India some time previous to the 9th century, and the existence of the sect in Ceylon.

In the Ante-Islamic portion of the Arabic chronicle of Abulfeda, published by Fleischer (Abulfeda, 'Hist. Anteislamica,' &c., ed. H. O. Fleischer, Leipzig, 1831, 4to), there is a curious chapter on the various tribes of India (p. 170, &c.) given on the authority of Shehrestani, a writer who flourished in the first half of the 12th century. Most of the Indian tribes, or rather sects, there noticed, are easily recognised, even under the somewhat adulterated names given to them by the Arab, as various branches of Brahmanic Hindus; and the only sect, the name of which bears any similarity to that of the Buddhists, the Behuditæ (al Bahûdiyyah, in the Arabic text), are described in a manner which removes every possibility of their being taken for followers of Sâkyasinha.

We have already alluded to the indirect testimony which Ebn Batuta gives of the existence of Buddhism in Ceylon, in describing the pilgrimage to the impression of Buddha's foot on Adam's Peak. In his account of Hindustan, he describes the burning of widows and other practices reprobated by the Buddhists, the prevalence of which is sufficient to convince us that Brahmanism was at that time the established religion of the country.

Marco Polo, who visited Tangent during the second half of the 13th century, describes the religious institutions of Kampion, the principal city of that province, in a manner to convince us that Buddhism was then the prevailing creed there, though the name is not mentioned. "The idolaters of Kampion," says he, "have many religious houses or monasteries and abbeys, built after the manner of the country, and in these a multitude of idols, some of which are of wood, some of clay, and some of stone, and covered with gilding. These images are held in extreme veneration. . . . Those persons amongst the idolaters who are

devoted to the services of religion lead more correct lives, according to their ideas of morality, than the other classes, abstaining from the indulgence of carnal and sensual appetites." (Marsden's 'Travels of Marco Polo.')

An early account, communicated probably by travelling merchants, of a Lama, or spiritual chief, among the Buddhist Tartars, seems to have occasioned in Europe, the report of a Prester John, or a Christian Pontiff, resident in Upper Asia. It deserves, however, to be noticed that Barhebræus ('Hist. Dynast.') speaks of a prince of the "Eastern Turks," who was a Christian, and who was named Ung-khan, or King John (*Malic Yuhannâ*): this prince reigned about the year 1202, and was dethroned by Gengiskhan.

However small is the information to be gathered from these passages of foreign writers as to the history of Buddhism, it is at least in accordance with the traditions preserved among the Buddhists themselves. For several centuries after the appearance of Sâkyasinha his sect seems to have flourished in India, and to have been tolerated by the Brahmans in nearly the same manner as the various divisions still existing among Hindus who follow the religion of the Vedas. Buddhism appears during this period to have penetrated the peninsula in every direction; and a succession of men of different parts of India, pre-eminent for piety, and considered as the living types of Buddha, followed him as his (figuratively) lineal descendants, and as the patriarchs or spiritual heads of the sect.

The numerous Buddhist temples, the remains of which are scattered over a wide extent of country in India, must be referred to this period. These remains it is not difficult to distinguish from others often found in their immediate neighbourhood, but erected for the purposes of Brahmanical worship. The principal characteristics of temples built for the Buddhists are the dagobas and the images of Buddha. The dagoba is a hemispherical or sometimes columnar structure containing some relic of Buddha, which usually stands either within or (as in Ceylon, Siam, &c.) close by a Buddhist temple, and is supported by a pede-tal, generally of a cylindrical shape, which varies in height. [HINDU ARCHITECTURE.] All images of Buddha represent merely human figures in a contemplative posture, sometimes standing upright or reclining, but more frequently sitting on a bench, or squatted down with the feet crossed and resting upon the thighs; the forefinger of the right hand sometimes rests on one of the fingers of the left, but usually the left hand rests upon the left knee, and the right hand is placed on the lap, being held open as if to receive an offering. The hair is always curled almost in the fashion of a wig, and the ears are extended and drawn down as if by the weight of some ornament suspended at them. A number of small cells is often seen near a Buddhist temple, apparently intended to afford shelter to pilgrims, or to ascetics and priests permanently resident near the sanctuary.

Ruins distinguished by these peculiarities have been found near Benares, at Buddha Gaya in Bengal, at Bag in Malwa, near the Ajunta pass, at Ellora, at Nasik, at Juner, at Carli, on Salsette, and at Guntoor. Some have even supposed that ruins of a similar structure, which have been found at Bamian in the Soliman Mountains, and at Manikyala in Afghanistan, belong to the same class. Those of Boro Bodo (or Bura booder) in Java, cannot be mistaken, and prove undeniably that Buddhism once prevailed in the very centre of that island. The simultaneous occurrence of traces of Brahmanic and of Buddhic worship in several of these places is most remarkable, and has not yet been satisfactorily accounted for: the most likely mode of solving the problem is, in our opinion, one of the three explanations suggested by Erskine, namely, that this proximity of their sanctuaries attests the friendly spirit that once prevailed between the two sects. Many notions peculiar to the mythology and cosmography of the Brahmans seem at an early period to have been received by the Buddhists, and to have been by them admitted as part of their own belief. This remark is well illustrated by Dr. Francis Buchanan's paper on 'the Religion and Literature of the Burmas' ('Asiat. Res.' vol. vii.), and by many passages in Sangermano's 'Description of the Burmese Empire,' edited by Dr. Tandy (Rome, 1833), which would, we think, be found on comparison to agree almost literally with passages in the Paurânic works of the Brahmans; and Captain Low, in his account of Tennasserim ('Journal of the Royal Asiatic Society,' vol. ii. p. 257), tells us that in that province dramatic representations founded on the history of Râma are a favourite entertainment of the inhabitants. We merely hint the probability of some influence having been exercised by this adoption of Brahmanic notions upon the architecture and sculptured decorations of temples, &c. erected by the Buddhists; and the possibility that, where remains of buildings of a Brahmanic character are found near others of Buddhist character, both *may* be the work of the latter sect.

The first foreign country into which Buddhism was introduced from India appears to have been the island of Ceylon. According to the traditions preserved in the Mahâvansi and Râjâvalî, chronicles of Ceylon, written in the Pali language, the island received its first civilisation through Vijaya, the son of Sinhabâha, king of Waggoo (in the northern Circars); who, being expelled from his father's kingdom, embarked with 700 followers, and landed on Ceylon on the day of Buddha's death; that is, according to the Cingalese computation, in April, 543 B.C. But Vijaya himself was not a Buddhist; and although there is a notion of a primeval Buddhism in Ceylon previous

to the age of the reputed founder of the sect, yet it was not till B.C. 307 that Ceylon was converted. Nearly eight centuries later, a learned priest named Buddha-ghôsana, who came from Jambudwîpa, on the continent of India, amplified and commented upon the tenets of Buddhism. This is said to have been done in the reign of king Mahânâma, A.D. 410-432. It deserves to be noticed, that according to the Mahârazaven, a chronicle in the Birman language, Pali books (and the doctrines of Buddha?) were brought from Ceylon to Pegu by a priest named Boudogosa; the date assigned to this occurrence is the year 940 of the Birman era, corresponding to A.D. 397. ('Alphabetum Barmanum seu Regni Avensis.' Edit. alt. Rom. 1787.) That the Birmans still acknowledge the reception of their religion and laws from Ceylon is attested by the curious fact that, about the year 1790, the king of Ava sent at separate times two messengers to Ceylon, to procure copies of their sacred writings; and in one instance the Birman minister made an official application to the Governor-general of India to protect and assist the person charged with the commission. (Symes, 'Embassy to Ava,' p. 304.) An opinion seems even to prevail among the Talapoins or priests of Ava, that out of the Birmese empire and the island of Ceylon, there are no true and legitimate priests of the laws of Buddha. (Sangermano, p. 83.) Two figures of Gaudama were sent from Tayoung, in Birma, by Capt. Hannay to Col. H. Burney, with inscriptions in the Deva-nagari character, of which the following is a part: "The not doing of every kind of evil, and purifying and cleansing the heart: these above-mentioned are the precepts of Buddha."

Of many of the sovereigns of Ceylon we find it mentioned that they formed tanks, or built and restored edifices for various religious purposes. Mahâsên, who reigned from A.D. 275 till 301, entered into negotiations with Guhasêva, king of Dansapura in Kalinga, to procure the surrender of a relic called the Dangistra Dalada, or right canine tooth of Buddha; it arrived in Ceylon during the reign of Mahâsên's son (A.D. 308), and has since then on several occasions played a conspicuous part in the history of the island, owing to the importance attached to it by the inhabitants. As early as the year 209 of our era we find a schism among the Ceylonese Buddhists mentioned; it originated in the doctrines put forth by one Wytooliya, which were adopted by the priests resident at a temple called the Abayagiri vihâra. An inquiry was instituted, and the doctrine having been found incorrect, the books in which it was set forth were destroyed. These strong measures did not, however, effectually check the progress of the schism; and during a considerable period we find indications of the alternate triumph and oppression of the heretical party. Another heresy, called the Wijrawâdîya, is stated to have been introduced into Ceylon from the continent of India during the first half of the 9th century.

With regard to the Cingalese, Mr. Robert Spence Hardy has published two valuable works, containing an account in considerable detail of Buddhism as it exists in Ceylon. In the first, 'Eastern Monachism,' which appeared in 1850, he has collected from Cingalese authorities an 'account of the origin, laws, discipline, sacred writings, mysterious rites, religious ceremonies, and present circumstances of the order of mendicants founded by Gótuma Budha;' the second, 'A Manual of Budhism, in its modern development; translated from Singhalese MSS.' appeared in 1853; and comprises a full relation of the doctrines and many of the legends, connected with the faith. The main doctrines are the same as those of the Sanskrit; the variations from them, as well as those of the legends, are such as have been introduced at subsequent periods, and we have preferred taking the statements from the original sources; but Mr. Hardy's books are well worth consulting.

But whilst Buddhism had thus gained ground in Ceylon, and was from thence propagated to the eastern peninsula, it had to endure in India a long-continued persecution, which ultimately had the effect of entirely abolishing it in the country where it had originated. The motive of these persecutions we confess ourselves unable fully to discover. That the caste of the Brahmans could not without jealousy and alarm witness the progress of a sect which threatened to overthrow their authority, and to deprive them of all those privileges which a creed and a social constitution, sanctioned by the Vedas, secured to them, is natural to suppose. But it is less intelligible why Indian sovereigns, after so long a period of toleration, should have consented to lend the Brahmans their aid in oppressing a class of their subjects whose principles, it would appear to us, ought rather to have recommended them as the natural protectors of the royal and civil authority against the ambitious arrogance of an hereditary priesthood; and the perplexity of this question is still increased by the forbearance shown in every part of India to the Jains, a sect so strikingly similar to the Buddhas, in all those particulars at least which seem to have drawn upon the latter the hatred of the Brahmans.

Mr. Wilson ('Sanskrit Dictionary,' 1st. edit., preface, pp. xv.-xx.) has shown that the religious wars of the Brahmanical Hindus with the Buddhists commenced in the 5th, and continued till the 7th century of our era. They have evidently contributed to accelerate the diffusion of Buddhism in other countries, though even in India the sect does not seem to have been entirely extinguished for several centuries after the persecutions terminated. Buddhism appears to have been first introduced into China about the year 65 of our era, by the authority of the

emperor Ming Ti. (Du Halde, 'Hist. of China,' &c., vol. iii., Eng. trans. 1741, 8vo.) A translation of some of the sacred writings of the Buddhists into Chinese is, however, stated to have been made in A.D. 418, by a priest from the northern part of India, whose name was Foo-too-pa-to-lo. (Rémusat, 'Mélanges Asiat.,' vol. i. p. 116.) According to the Chinese and Japanese list of Bodhisattwas, Pan-jo-to-lo or Banneyadara, the 27th of the series, was the last representative of Buddha, who died in India (A.D. 457); his successor, Bodhidharma, went to China (A.D. 499), and was followed by five Buddhist patriarchs there. From China Buddhism was subsequently extended to Corea, A.D. 528, and to Japan, A.D. 552. M. Stanislaus Julien says, Buddhism was introduced into China about A.D. 65, and spread rapidly—the Buddhist books of India having been brought immediately by missionaries, by pilgrims on their return, and by the exiles driven out by the persecution of the Brahmans; and he gives a list ('Journal Asiatique,' for Nov.-Dec., 1849), of the works translated into Chinese. He states also, that there is a Chinese catalogue, printed in 1306, with the Sanskrit and Chinese titles ranged side by side, to the number of 1440, forming 5586 volumes. Some of these works are translated also into Tibetan and Ugrian. In 1853 and 1857, M. Julien also published the translation of a Chinese work, the 'Pilgrimage of a Chinese Buddhist pilgrim, from China to India, to study the religion of the great reformer in his own country.' The volumes contain much interesting matter, particularly as relates to the geography of the countries he passed through; but his statements as to the doctrines of Sàkya differ in no material degree from those of Burnouf.

About the middle of the 5th century, Buddhism seems to have been carried to Java; whither, however, Brahmanical settlers had probably preceded it. It is as yet uncertain whether the Buddhism of Java was of Ceylonese or of Indian origin. According to a tradition current in Java, the strangers, who civilised the island, came from Kling (that is, Kalinga, or the northern Circars), a name by which the modern nation of Java seem to designate the whole continent of India.

Buddhism was also introduced into Cashmir very early. According to the local history it continued to flourish there till the reign of Nara, B.C. 298, when the Brahmans expelled the followers of Buddha, and burned their temples. (Wilson, 'Asiat. Res.,' vol. xv. pp. 26 and 81.)

Dr. F. Buchanan (Hamilton) is of opinion that the time of the introduction of Buddhism into Nepâl may be fixed about the commencement of the Christian era, when "Sàkya, the last great teacher of the Buddhists, passed through the country and settled at Lassa, where he is supposed to be still alive in the person whom we call the Grand Lama." ('Account of Nepâl,' p. 10. Compare pp. 32, 56, 190.)

From the Mongol chronicle, published by Schmidt, we learn that Buddhism was for the first time introduced into Tibet during the reign of Hlatotori, in A.D. 407. The great grandson of that king, Srongdsan Gambo, who ascended the throne in A.D. 629, sent Tongmi Ssambhoda, attended by sixteen companions, into India, for the purpose of being instructed in the art of writing. Along with an alphabet, which has till the present day preserved its similarity to the Indian Devanagari character (see the plates accompanying Mr. Hodgson's paper in the 16th vol. of the 'Asiatic Researches') these missionaries seem to have carried the first writings on the religion of Buddha into their native country. But not all the succeeding kings of Tibet were favourable to the new religion. Glang Dharma, who reigned from 902 to 925, as well as his son Gorel Shakikchi (925—977), were hostile to Buddhism, and persecuted its followers. After a period of persecution which lasted 86 years, the doctrine was re-established in Tibet, in the year 988. M. Huc (in his 'Souvenirs') has given specimens of a Tibetan work attributed to Sàkya, entitled the 'Forty-two points of instruction delivered by Buddha,' and these points are entirely in unison with those produced from the Sanskrit by M. Burnouf. Nearly three centuries subsequent to this restoration Buddhism was introduced among the Mongols, during the reign of Godan, a grandson of Gengiskhan, who was converted to the new religion A.D. 1247, by Sâkya Pandita, a teacher (Bodhisattwa?) who came from the south. (Schmidt's 'Ssanang Ssetsen,' pp. 25, 29, 48, 113, &c., and the notes of the translator, pp. 325, 329, &c.)

M. Huc says ('Souvenirs d'un Voyage dans la Tartarie, le Thibet, et la Chine, pendant les années 1844, 1845, et 1846'), that of all the Buddhist nations he has visited, the Mongolians appear to be the most sincere; then come the Tibetans and the Cingalese; but that the Chinese are merely nominal followers, and have almost universally fallen into complete scepticism.

The collection of writings regarded as sacred by the Buddhists is probably as voluminous as that of any sect that ever existed. The language in which the Buddha sages originally committed their doctrine to writing we believe to have been the Sanskrit, from which they were subsequently translated into the Pali, and into other languages current in the several countries where Buddhism was introduced. A considerable number of Sanskrit records of Buddhism were some years back procured in Nepâl by Mr. B. H. Hodgson; and it is but natural to suppose, that among them some of the ancient and original treatises on the doctrines of Buddhism should have been preserved. The most important of these sacred writings in the estimation of the Nepâlese Buddhists are nine "Purânas," also named the nine "Dharmas," narrative works, in which elucidations of the Buddha

doctrines seem to be blended with a legendary account of the life of Buddha and the most eminent sages of the sect. Besides these they possess works called "Tantras," which contain prayers and forms of invocations, and are illustrated by ample commentaries; and also collections of prayers, apparently composed for use on certain occasions, which are called "Dhâranis." (See Mr. Hodgson's enumeration of the principal existing Buddha writings of Nepâl, in the 16th volume of the 'Asiatic Researches,' p. 422, &c.) Quotations in Sanskrit from a collection of "Sûtras," or short aphorisms, attributed to Buddha himself, occur in Sanskrit works on the Vedânta philosophy.

In the Essay on Buddhism by Kitelegama Dewamitta Unnanse, a native of Ceylon (printed in the Ceylon Almanac for 1835, pp. 211—229), 84,000 sermons preached by Buddha are mentioned (p. 226), which the writer of the Essay says may be contemplated as his personification (p. 229). The Mongol Buddhists possess a sacred work called "Gandjour," which is written in the Tibetan language. Timkowski saw a copy of it in a temple at Purga, in the country of the Kalkas Mongols, which consisted of 108 volumes. Chests revolving on an axis, and covered with prayers in large gold letters, are frequently placed in the Buddhist temples among the Mongols, in order that persons who cannot read may come and turn them round as long as their zeal prompts them, which is considered as efficacious as if they recited the prayers themselves.

It is a notion deeply rooted in the minds of all Hindus, often repeated in the Vedas, and variously explained and commented upon by the different schools of Brahmanic philosophy, that the visible world and everything relating to it is but the transient manifestation of the Deity, without real or permanent existence; that the confinement of the human soul, itself an emanation of the Divine spirit, in a perishable body, subject to all the changeful accidents of matter, is a state of misery; and that every effort of man during life should be directed towards ensuring the entire emancipation of his soul after death, that is, not only its liberation from the necessity of undergoing another birth, and being invested with a body, but altogether its release from individual existence, and its direct return to a lasting union with the Divine Being. This notion developed in a peculiar manner, forms likewise the basis of the Buddha creed.

The Buddhists of Nepâl, who have preserved the ancient doctrines of the sect with the greatest purity, and concerning whose religious notions our information is as yet more explicit than any that we possess of the tenets held by the Buddhists of other countries, are divided into four schools, which differ partly in the manner in which they teach that the Divine spirit was active in the production of the world, and partly in the method which they prescribe for effecting the liberation of the soul after death. We will endeavour briefly to state the peculiar doctrines of each of these schools, following chiefly the 'Quotations in Proof," published by Mr. Hodgson in the 'Journal of the Royal Asiatic Society,' vol. ii. p. 295, &c. All concur in admitting the primeval existence of the Deity, who was when nothing else was, and who is thence called Adi-Buddha or "the First Buddha."

1. According to the Swâbhâvika school, Swâbhâva, a sort of plastic faculty, springing from, or rather identical with, Iswara, or God, is the source from which the elements and all things and beings proceed, and into which they are ultimately to be re-absorbed. The universe constantly revolves between Pravritti and Nirvritti, or creation and re-absorption or annihilation; and this eternal change of existence and non-existence is the system and law of nature, without any co-operation of will or design on the part of Iswara. (Hodgson, l. c. p. 297, No. 9.)

2. The Aiswarika school attributes more of a personal character to the Deity, and asserts that the creation of the world was the deliberate act of Iswara. Nirvritti, that is, perfect calmness or repose, is his proper and enduring state: but for the sake of creating the universe he became Panchajnânâtmika, or "endowed with five-fold consciousness," and produced the five divine Buddhas (Vairochana, Akshobhya, Ratnasambhava, Amitâbha, and Amoghasiddha), who became the authors of the elements, and by the agency of the five Bodhisattwas, beings produced by them, were the creators of the world. These five Bodhisattwas therefore, as delegates of Iswara, produced all things by their fiat. (Hodgson, l. c. p. 299.)

3. The Kârmika school (which along with the Yâtnika is supposed by Mr. Hodgson to be of more recent origin than the two first) appears to have speculated chiefly on the means best calculated to procure the release of the soul from its connexion with matter; and as it deduces the procession of all things into existence from avidyâ (error, delusion), so it maintains that the regressive movement towards non-existence must be effected by true knowledge. The "error" here alluded to is the groundless belief in the reality of the external world. This belief, when arising in the un-embodied sentient principle, is attended with a longing after the objects which it supposes to exist: hence individual consciousness springs, and a subtile personal frame forms itself as the seat of that consciousness: a perception of sensual objects follows, which produces desire in the subtile frame, and leads to its corporeal conception and physical birth. The progress of the soul towards matter is therefore the effect of a succession of acts (Karma—whence the name of the school Kârmika) on the part of the soul; and its liberation must be sought by relinquishing the erroneous notion of the reality and stability of external objects; for when this great error is

abandoned, all its consequences vanish with it, along with all mundane things and existences which are only derived from thence. This school likewise inculcates the doctrine which is very current in India, that the actions of a man during former existences determine his destiny in the present life: "Although I had acquired a perfect body, still in this body even defect again appeared, because I had still to expiate a small portion of the sins of former births: so said Sâkya Sinha." (Hodgson, l. c. p. 304.)

4. The Yâtnika school has directed its attention to the same problem as the preceding, and proposes to solve it in a similar manner. The cause of the creation of the world, say its followers, is Yatna, that is, an effort or a determined will on the part of the Creator. In the same manner in the affairs of this world all difficulties are overcome by Yatna; and so the attainment of that wisdom which procures the liberation of the soul from matter depends on (Yatna) a conscious intellectual effort. (Hodgson, l. c. p. 305.)

Various terms are in use to denote the state of final liberation of the soul, which is by all these sects proposed as the object to which man should aspire; but the expression, which Buddhas seem to be particularly fond of employing, is Nirvâna. This word is properly a passive participle of the Sanskrit root *vâ*, "to blow" (as the wind), with the preposition *nir*, "out, away from," prefixed to it; and its primary meaning is "blown out, extinct," as a candle which is gone out, and hence "departed, defunct;" but the word is likewise used with the preposition *nir* taken in a negative sense, and it then signifies "calm, unruffled," or, employed as a substantive, "calmness, tranquillity;" whence is derived its use as a description of the happy state of imperturbable serenity and apathy at which the soul arrives on its re-union with the Divine Essence.

The popular belief in Nepâl attributes the superintendence of the work of creation especially to Padmapâni, one of the five divine Bodhisattwas above alluded to. He is represented as having produced the three Hindu deities Brahmâ, Vishnu, and Siva, and as having assigned to them respectively the task of creation, preservation, and destruction. It is Brahmâ therefore who, according to this account, created the world. Another account conceives Manjusri to have been the appointed architect of the world, while Padmapâni, by Adi-Buddha's special command, created all animate things.

The cosmography of the Buddhists divides the entire universe into four principal divisions. The first consists of thirteen Bodhisattwa-bhuvanas, or mansions, created by Adi-Buddha, and including the Agnisht'ha-bhuvana, his own eternal abode: devout followers of Buddha will proceed to one of these mansions after death. Below them is the second division, which consists of eighteen mansions, called Rûpyavachara-bhuvanas, and created by Brahmâ; farther down is the third division, comprising the six Kâmavachara-bhuvanas, which are subject to Vishnu; and below them are the three Bhuvanas called Arûpyavachara, superintended by Siva, and forming the fourth division. Pious worshippers of Brahmâ, Vishnu, and Siva will, after death, proceed to these divisions respectively. (Hodgson, 'Transact. Roy. Asiat. Soc.' vol. ii. pp. 233, 234.) Below these Bhuvanas another series of mansions begins, which belong to Indra, Sûrga (the sun), Chandra (the moon), Agni, Vâyu, &c. Then follows the earth, with its seven dwîpas or continents, separated by seven seas. Below the earth is the "world of waters," on which the earth floats as a boat; and below the "world of waters" are the seven Patalas or infernal regions, six of which are the abode of the Daityas or malignant spirits, and the seventh, which is divided into eight compartments, is the hell of sinners.

Mr. I. J. Schmidt has translated an extract from a Mongol work, giving an account of the creation ('Ssanang Ssetsen,' p. 302), according to which, nonentity or empty space is the original state of everything that exists. The creation of the world is in this account represented as proceeding from the "region of the second Dhyâna" (or the self-contemplation of the Deity), and as affected by the "region of the first Dhyâna" (or the divine will and agency?), which comprises the abodes of Brahmâ, Vishnu, and Siva. A wind arises in this region, which, by blowing downwards, produces the abode of the superior order of spiritual beings; and in the same manner a succession of abodes of spirits gradually inferior is formed, till the winds reach the lowermost limbus of empty space, and there produce a condensation of air which becomes the germ of the material world. All these regions or abodes, with the exception only of the "region of the second Dhyâna," are subject to alternate production and dissolution.

Along with many other mythological conceptions, the Buddhas seem to have borrowed from the Brahmans their doctrine of the four yugas or periods of time into which a kalpa, or the duration of one existence of the world, is divided. These yugas they distinguish by the gradual decreasing length of men's lives in them. In the first yuga of the present kalpa, men lived 80,000 years; in the second, 10,000; in the third, 1000; and in the present fourth yuga, which is again subdivided into four periods, the duration of men's lives will be successively diminished from 100 to seven years, and towards its termination the stature of men will only be the height of a thumb. (Hodgson, 'Transact. Roy. As. Soc.' vol. ii. p. 235.)

One of the essential diffences of the Buddhists from the Brahmanical Hindus is the character which they attribute to their prophets or saints, and especially to the founder of their sect. Sâkyasinha, according to the uniform belief of all his followers, was not, like Râma or Krishna, an avatara, or incarnation of the Deity, but a mortal man, who by his sanctity and devotion attained the highest eminence, and after his death proceeded at once to the final re-union with Adi-Buddha. He had been preceded by six persons similar to him in holiness, whose names were Vipasya, Sikhi, Viswabhu, Kukuchhanda, Kânchana (or Ranaka Muni), and Kâsyapa: but nothing is told us of the deeds of these mythological beings, and they are even enumerated variously, the first three being sometimes omitted. Another saint of this description is expected to appear on earth when 5000 years shall have elapsed after the death of Sâkyasinha. The appearance of the latter was followed by a succession of Bodhisattwas, that is, mortals born perfectly virtuous, whose souls are no longer subject to the necessity of terrestrial existence, but who voluntarily descend to the earth in order to promote the welfare of mankind. These Bodhisattwas have gradually assumed the character of reappearances of Sâkyasinha himself, in which capacity the line is continued till the present day in the several Lamas of Tibet; for it is admitted that the reviviscence of the sage in more that one individual simultaneously involves no contradiction.

This dogma of a continued identity of person in the successive Lamas is strikingly illustrated by a passage in a letter addressed in 1774 by the Lama of Teshoo Loomboo to the Governor-general in India, in which he applied for the grant of a small piece of ground near Calcutta, stating as a motive for his request, "that although in the different periods of his reviviscence he had chosen many regions for the places of his birth, yet Bengal was the only country in which he had been born twice, for which reason he had a predilection for it beyond any other." (Turner's 'Embassy to Tibet,' pref. p. xv.)

The Buddhists reject entirely the authority of the Vedas, and the religious observances, sacrifices, and ceremonies which are prescribed in them and kept by the Hindus. They have no distinction of hereditary castes. Their priests are chosen from all classes of men: they are obliged to live in celibacy, but may resign their sacerdotal character, if they desire it, and are then permitted to marry. In Ceylon three orders of priests are distinguished: those of the highest order (who seem to be the only true Buddha priests in the island) are usually men of high birth and learning, and are supported at the principal temples called vihâras, most of which have been richly endowed with farms, &c. for their maintenance by the former monarchs of the country. A translation of some highly interesting inscriptions in which grants of this kind, and the conditions attached to them, are recorded, has been given by Mr. G. Turnour in the Ceylonese Almanac for 1834, p. 178, &c. All Buddha priests go bare-headed, and with their heads shaved; but to defend themselves from the sun they carry an umbrella made of the leaf of the palmyra-tree, and Knox mentions that they are permitted in Ceylon to wear this screen "with the broad end over their heads foremost, which none but the king does." In Ceylon they wear a yellow coat, gathered together about the waist and coming over the shoulder, and girt about with a belt of fine packthread. In the appendix to Symes's Embassy to Ava there is an account of the ceremonies used in the Birman empire at the consecration of a Buddhist priest. The candidate is reminded of four principal commandments, which require him to observe strict chastity, not to commit murder, not to steal, and not to practise sorcery, or to disgrace the priestly character by covetousness; and he must promise that he will procure his maintenance by perambulation and begging; that he will wear a particular kind of dress; that he will dwell in houses of a certain description, and that he will endeavour to turn to some use things thrown aside as useless by others, or to discover the medicinal powers of plants not previously employed. Buddhist priests are not forbidden the use of animal food, but they must not slaughter animals themselves. Convents for priests, as well as nunneries, exist in all countries where Buddhism has been introduced. Their processions and their forms of religious worship are described as being attended with much pomp and splendour, and well calculated to impose upon the multitude. The first Christian missionaries that proceeded to Tibet were surprised to find there, in the heart of Asia, monasteries, processions, festivals, a pontifical court, and several other ecclesiastical institutions resembling those of the Roman Catholic church; and many were induced by these similarities to consider Lamaism as a sort of degenerated Christianity. It should, however, be remembered that at the time when Buddhism was introduced into Tibet, somewhere about the middle of the 13th century, Nestorian Christians had ecclesiastical settlements in Tartary; that Italian and French messengers who visited the court of the Khans carried church ornaments and altars with them, and celebrated their worship in the presence of the Tartar princes; and that an Italian archbishop sent by Clement V. established his see at Karakorum, and erected a church in which divine service was performed with all the ceremonies usual in Europe. It is by no means improbable that the Lamas, whose court then began to assume a splendid exterior, should have adopted some of the forms of the Catholic service as they saw it celebrated by these foreigners, and that imitation should thus have co-operated in producing a similar mode in conducting the divine worship in two religions essentially foreign to each other, and this belief is accepted by M. Huc in his 'Souvenirs d'un Voyage dans la Tartarie, le Thibet, et la Chine pendant les années 1844, 1845, et 1846,' Paris, 1850.

BUDDING, an operation in horticulture, by means of which the branches of one kind are often made to grow upon the stem of another kind. It is stated in the article BUD [NAT. HIST. DIV.], that this organ has the power of growing when separated from the mother-plant. Not only will it grow, but it will emit roots, form a stem, and become in time a new individual in all respects similar to its parent, retaining all the special peculiarities of the latter. In this respect it differs from a seed, which in general is not capable of doing more than propagating a species, without any power of preserving, unless accidentally, the peculiarities of the individual from which it sprang

Gardeners have availed themselves of this property in leaf-buds for the purpose of artificial propagation, either by planting the separated buds in earth, or by introducing them into the branches of other plants. The former is called propagation by eyes; the latter only is technically named budding.

Budding is usually executed thus: With a very sharp knife a fully formed bud, and the leaf to which it is axillary, are pared off the branch, along with about half an inch of bark adhering to them at the upper end, and an inch and a-half at the lower end. By holding the leaf firmly between the finger and thumb of the left hand, with the wounded side of the paring uppermost, the operator is able to disengage from the bark the small slip of wood which adheres to it, and by a jerk to snap it off the paring, leaving nothing but the cellular centre of the bud adhering to the bark. This done, he makes in the branch to be operated on, one incision transversely through its bark, and another longitudinally at right angles to the first and in a direction downwards, so that the two together resemble the figure of the letter **T**. He then, with a flat ivory blade, lifts up the bark on each side of the longitudinal incision, so as to separate it from the wood, and inserts beneath it the prepared bud, which is gently pushed downwards till the bud itself is a little below the transverse line. This done, a ligature of bass is carried round the stem so as to bind the bud firmly to the new wood on which it is placed. If the operation is well performed, the bud will thus be fixed on a new plant in the same position as it occupied on the branch from which it was taken; the mouths of the medullary rays of its bark will unite with those of the wood of the stranger plant, it will be kept in contact with a continual supply of food oozing out of the alburnum on which it is placed, it will absorb that food, and soon accustom itself to its new position. Then, when the growing season arrives it will be stimulated by light and warmth to attract sap from the wood to which it has adhered, it will push forth new wood of its own over that which it touches, and thus will form as intimate a union with its stock as it would have formed with its parent plant. In order to enable the latter to do this, it is customary to head down budded branches to within a few inches of the buds, so as to compel the sap which oozes from the roots to expend itself upon the former; a few natural buds near the artificial bud are allowed to push sufficiently to attract the sap to their neighbourhood, and are then destroyed; when the stranger bud has pushed to the length of a few inches, it is tied to the stem so as to be secured from being broken off by accident; and finally, when it is quite secure, that small portion of the stem of the stock which had been left above the bud in the first instance is cut away, and the branches produced by the bud become the head of the new tree.

Such is the general nature of budding, but like all other operations it can only be well performed after some experience. It may be varied within certain limits, and there are in fact a few other modes, such as *reversed-budding* and *scallop-budding*, which are occasionally practised (see Loudon's 'Encycl. of Horticulture,' new edition, p. 656); but that here described is the most common and the best. Roses, plums, peaches, nectarines, cherries, and many other plants are chiefly propagated thus, and there is no theoretical reason why it should not be extended to all species. In practice, however, it is occasionally found impracticable, as in heaths, in vines, &c., owing to specific causes, which vary in different instances.

Budding is usually performed in the months of July and August, because at that season the bark separates freely from the wood, and the young buds are fully formed; but whenever the two latter conditions can be satisfied, the operation may take place equally well.

It must, however, be observed, that the bud of one plant can only be made to grow upon the wood of another when both bud and stock are nearly related botanically. Thus, the orange tree will not bud on the pomegranate, as is supposed by the ill-informed. Roses will bud upon roses, but not upon currants; apples will bud upon pears or thorns, pears upon medlars or quinces, and apricots upon plums, because all these species are closely related; but an apple will not bud upon a plum or a peach, because, although they are allied to a certain degree, yet their consanguinity is not sufficiently strong.

BUDE LIGHT. This, together with many other modes of illumination for domestic, scientific, and manufacturing purposes, will be described under LIGHTS, ARTIFICIAL.

BUFFOON, a jester; the name is said to be derived from "buffa," a word of the corrupt latinity of the middle ages, synonymous with *alapa*, that is, a slap on the cheek. *Buffe* and *Buffet* in the old French, and *Bofetada* in Spanish, were used in the same sense. Mountebanks and clowns in the farces used frequently to swell their cheeks with wind and then give each other a slap which produced a noise, to the amusement of the spectators. Hence are derived the word *Buffones* in Latin, the French *Bouffons* and the Italian *Buffoni* (Ducange). *Buffare*, or *sbuffare* in Italian, means to puff the wind through the mouth. The English word buffoon is now generally used in a contemptuous sense. The Italians have two distinct words, *Buffo* and *Buffone*. Buffo is a theatrical term: opera buffa, comedia buffa, is a burlesque play, in contradistinction to opera seria and commedia di carattere, or serious comedy. The buffo is one of the principal characters in those plays, corresponding to the English clown; in an opera there are often two, primo buffo and secondo buffo. Buffone in Italian means a funny ludicrous fellow, but not always in a contemptuous sense. *Bouffon* in French and *buffoon* in English have been occasionally used as synonymous with king's fool, a well-known character at courts in former times.

BUILDING, or the art of constructing edifices, is defined by some writers as practical, in contradistinction to theoretical, architecture; but, without a previous explanation of the meaning of the term architecture, such a definition is imperfect, since, although building is necessarily included or involved in the execution of all architectural works, many of the works produced by the builder have either no claim at all, or a claim by no means generally admitted, to be considered architectural works. In the practice of civil architecture, the builder comes between the architect who designs the work and the artisans who execute it; and, in a commercial point of view, between the party by whom the capital is provided on the one hand, and the merchants and manufacturers who provide the necessary materials, and the workmen whose office it is to shape and unite them, on the other. For the temporary employment of his own capital and the exercise of his directing skill, he is usually remunerated by charging his employer for labour and materials at a higher rate than he has paid himself; and, for the mutual security of all parties, he generally works by contract, either undertaking to execute the building, with all contingent works, for a given gross sum, which is termed a lumping contract, or agreeing to perform the whole work at certain specified rates per yard, rod, foot, &c., according to the nature of the work, the quantities being measured according to established rules.

An article upon the multifarious operations connected with building would not only require more space than is consistent with the plan of this work, but would also involve the repetition of much information already given under various heads. Such a general treatise is supplied in the long and elaborate article 'Building,' in the 'Encyclopædia Britannica,' contributed by Mr. Hosking; a treatise which may be consulted with advantage by readers who wish to go very fully into the subject. Here we propose to do little more than give such an outline as may enable the reader to turn readily to those portions of the work in which the various branches of the general subject are treated of.

Of the distinction between building, properly so called, and architecture, some account is given, together with remarks on ancient styles of building, in the article ARCHITECTURE; and under HOUSE, the subject of domestic architecture, which it is all-important for a builder to be well acquainted with, is treated at some length. From the last-mentioned article it will be evident that the attention of the builder should be directed rather to matters of utility and comfort than to such as relate to ornament; although as many houses are erected without the aid of a professed architect, it is desirable that he should be so far acquainted with the principles of architectural design as to avoid unpleasant proportions and incongruity of ornament. Where the choice of site remains with himself, he should avoid a low and damp situation, and also a situation exposed to cold winds. A good supply of water to the house, and sufficient fall to ensure perfect drainage, are essential; and as a general rule, the advantage of southern and western frontages should be secured as much as possible. The direction of the prevalent winds is a point to be carefully considered, in order that the openings of doors and windows may be so arranged as to avoid draughts and smoky chimneys, which are not unfrequently occasioned by want of due attention to this matter. [SMOKE.] Such points being duly considered, drawings of the intended building, showing not only its exterior form, but also its interior arrangements and the substance of its walls and partitions, as explained under DESIGN, ARCHITECTURAL, are prepared; after which the actual construction commences by the preparation of a firm foundation for the structure, as described under FOUNDATION. The excavation formed for the foundation should be executed with the utmost care, and the level must be produced by the removal of earth until an even surface is obtained; the production of a level by filling up hollows with loose materials is extremely hazardous. For the mode of laying foundations under water see COFFERDAM.

The articles BRICKWORK and MORTAR contain information on the construction of brick walls; but the Metropolitan Buildings Act (18 & 19 Vict. c. 122), contains provisions, particularly in the schedules, which must be carefully attended to by every builder.

The various modes of bonding brick walls are sufficiently described in BRICKWORK; but these relate simply to the mode of arranging the separate bricks or component parts into a solid and cohesive wall or mass of brickwork. Much more than this, however, is required in building the walls of a house, in order to prevent, as much as possible, their strength from being impaired by the necessary openings for doors and windows, and to afford the means required for connecting the door and window frames, floors, partitions, and other woodwork, with

the shell of the structure. The effect of apertures in a wall is counteracted by the introduction of inverts, or inverted arches, in the portion of wall beneath them, and of discharging arches, which may either be left visible or not, over them. The fixing of door and window frames, and other small woodwork, is provided for by the insertion in the wall of *wood-bricks*, or blocks of seasoned wood resembling bricks in form and size. *Lintels* are bars of wood inserted, in lieu of arches, over the apertures of doors and windows; but they should always be surmounted by discharging arches abutting upon the solid brickwork beyond the ends of the lintel, which, in such a case, may be made to tail into the wall to a very short distance only beyond the sides of the aperture. Where, however, there is to be no discharging arch over the lintel, it should be of sufficient length to tail considerably into the wall, and its ends should rest upon transverse templates or wood-bricks built into the wall. *Templates* are pieces of timber often three or four feet long, which are let into the wall after the manner of wood-bricks, either for the purpose of fastening to, or of supporting the ends of beams let into the wall, and distributing their pressure over a considerable space. Discharging arches should be turned over these, and over the ends of beams, so that their shrinkage, or even their decay or destruction by fire, should not be sufficient to affect the stability and cohesion of the wall. Some floors are so framed together that they may be connected with the walls by a few principal beams, the ends of which rest upon templates; but more usually the ends of the joists rest upon long pieces of timber called *wall-plates*, which are let into the brickwork, and serve to distribute the weight equally. *Bond-timbers* are occasionally inserted with a special view to the distribution of strain, but their liability to swelling and shrinking, as well as their perishable and combustible character, render it desirable to bond the structure as perfectly as possible without them. Timbers should, in all cases, be kept clear of the chimney flues, or, if this be impossible, should be guarded with iron so as to prevent the possibility of a spark coming in contact with them. The various plans which have been introduced of late years for securing timber from the ravages of dry-rot, and rendering it incombustible, greatly lessen the risk of employing it in walls. [TIMBER, PRESERVATION OF.] The variations of size occasioned by changes of temperature render the combination of iron with brickwork even more hazardous than the use of timber, though the employment of straps of hoop-iron laid in the mortar between the courses of bricks is found advantageous under certain circumstances. An instance of its employment in the construction of arches without centering is mentioned under SCAFFOLDING. The brittleness of cast-iron renders it very unfit for use where unequal settlement may occur. The construction of efficient drains should be attended to in an early stage of the building. This subject is fully treated under SEWERS, and it is only necessary here to observe, that in order to increase the current and prevent the deposit of sediment, all drains should be concave at the bottom, and that where they pass through houses, or in any case in which it is probable that they may have to be opened, it is desirable to make the top consist of flat paving-stones or tiles, laid in cement; as a circular, barrel, or, as it is sometimes called, a gun-barrel drain, unless its fall be very considerable, will be likely to involve much trouble and expense in opening and cleaning. Where the drain is straight, and short enough to be raked, this matter is not of consequence. It is a usual and convenient plan to conduct the drain under a doorway, between the sill and the invert; but when this cannot be done, an arched opening, called a bull's-eye, must be made in the wall where it passes through. In addition to the air-traps which, as described under SEWERS, should always be placed at the entrance of drains, a very simple trap may be formed at any convenient point in their course, by sinking a small well a few inches below the bottom of the drain, and building in with the brickwork of the drain a flat piece of flagstone in such a manner as to form a dipping-valve resembling that shown in SEWERS, so that no water can escape until the well is filled, and no air can pass the trap unless the well becomes, by evaporation, so dry as to allow it to pass under the edge of the dipping-valve.

As the erection proceeds, contrivances for supporting the workmen and materials are required, of which an account is given under SCAFFOLDING. In the basement story of a building, the partition walls, as well as the external and side or party walls of a house are usually formed wholly of brickwork, but in the upper stories they are generally of lath and plaster, on a framed and trussed timber foundation, or of what is technically called *brick nogging*, which consists of a framework of quartering, similar to that used for lath and plaster, but having the intermediate spaces between the timbers filled up with brickwork, thus forming a wall either 4½ or 3 inches thick, according to whether the bricks are laid flat or on edge. Though strengthened by the upright quarterings or timbers, the brickwork, being so thin, should be strengthened or bonded further by the introduction, at intervals of not more than six courses, of horizontal bars of wood called *interties*, or *nogging-pieces*, skew-nailed at each end to the quarterings. Some builders, in lieu of brick nogging, use half-brick, or 4½ inch, walls carefully built in cement, and strengthened with iron hooping, a plan which has the advantage of greater security from fire. Such partitions also check, more effectually than those in which much timber is introduced, the transmission of sound from one room to another. The joints of brickwork in internal walls, and in such external walls as are to be covered

with plaster, stucco, or cement, are left rough, with the mortar projecting from the joints, because the inequality of surface thus produced causes the plaster to adhere better; but in such external walls as are to be exposed to view, the superfluous mortar is removed, and each joint is *drawn*, by applying the point of the trowel so as to flatten the joint, or rather to leave it slightly concave. The use of thick beds of mortar between the bricks is not only injurious from the settlement thereby occasioned, but also because the compression of the mortar causes it to bulge out at the joints, and so to counteract the effect of drawing with the trowel. The joints, being thus rendered convex instead of concave, catch and absorb the rain which trickles down the wall, and when a frost comes this absorbed moisture freezes, and occasions the mortar to crumble away, thus involving the necessity of *pointing*, or filling in the joints with new mortar, to preserve the wall. To do this, the old mortar must be scraped out to the depth of three-eighths of an inch, or further if needful, and the joints must be thoroughly cleaned and moistened before inserting the new mortar, which should be of the best quality. Mortar for this purpose is commonly mixed with forge ashes, which give it a bluish tinge, and render it better fit to resist injury from weather. Cement is sometimes used for the purpose in lieu of mortar. If the work be required to be very neat, each joint is finished with a narrow line or parallel ridge of fine white putty or mortar, made principally of bone-lime. In the application of this kind of pointing, which is termed *tuckpointing*, to an old wall it is usual to wash and colour the whole surface of the brickwork; and when, by the carelessness of the bricklayer, the vertical joints which should come in a line over each other, technically called the *perpends*, have not been properly attended to, the misplaced joints may be filled up with brick-coloured putty, and false joints made in the proper places. Mortar used for the *pargetting*, or internal plastering, of brick chimney flues is mixed with a little cow-dung, to prevent its peeling off from the heat. The top of a brick-wall, whenever it is not covered by the roof, must be protected by coping [COPING], which in single-brick walls is often formed simply by a row of bricks set on edge in cement across the wall, and called a *barge-course*, a name which is also given, with more propriety, to the projection of a roof over a gable-end. [BARGE-COURSE.] This kind of coping is very imperfect, because, as it has no projection or inclination, it does not throw off the water. It may be improved both in appearance and efficiency by laying underneath the barge-course two double courses of plain tiles, with their joints broken, and their edges projecting about an inch and a half on each side of the wall, or by a similar application of paving tiles. Stone coping, however, which can be made of any width, and properly sloped or weathered and throated, is far better. For ornamental brickwork proper coping-bricks are made, which if well set in fine mortar or cement may be equally efficient with stone, and have a better architectural character. It may be remarked, generally, that brick walls often suffer injury in consequence of the insufficient projection of copings and cornices, which ought to throw off water as much as possible from the face of the wall.

The established mode of measuring brickwork is explained under BRICKWORK. Brick and tile paving, which are noticed under FLOOR, are measured by the superficial yard of 9 feet, and tiling, for which see ROOF and TILE, by the *square* of 100 superficial feet.

Of the use of stone in building some account is given under MASONRY, ASHLER, and RUSTICATED WORK. Rubble-work is more difficult to execute well than building with cut or squared stones, since there is great danger of trusting too much to the mortar. Unwrought stones, however irregular in shape, ought to be so laid together that the wall would stand if laid to a considerable height without mortar. It is of course desirable to give the outside of a rubble wall as neat an appearance as possible; but care must be taken in doing so to bond the facing stones as thoroughly as possible with the centre of the wall, and not for the sake of show, to expose the bed of the stone, or the flat surface formed by its stratification, in the face of the wall, as a stone so applied cannot be firmly bonded into the wall, and its flat surface is far more liable to injury from the action of the atmosphere than a surface cut at right angles with its plane of stratification. It is better to bond the wall by means of many stones extending partly through its thickness, alternately from each side, than to use a few thorough stones, or stones reaching completely from face to face, and yet leave the greater part of the wall like two shells enclosing an irregular core of coarse rubble. Stone copings and some other kinds of stone-work are frequently cramped together with fastenings of iron or copper, run in with melted lead; but unless these metal fastenings, especially those of iron, can be thoroughly secured from the influence of the atmosphere, they are liable, from oxidation and the effect of changes of temperature, to produce much harm, and therefore it is better, if possible, to use tenons, dowels, joggles, or dowels of stone or wood, protecting them also from the weather. The principal purposes for which stone is introduced in brick buildings are enumerated under MASONRY, to which we need only add that the setting of stone window and door -sills is usually delayed as long as possible, to give the brickwork time to settle, because a very slight inequality in the settlement would cause them to break, being long and thin. The brittleness of stone, indeed, renders it always unadvisable to use it in pieces of great length of bearing, and very important to make the joints perfectly even. In the jointing of columns, for example, the

ends of the adjacent stones must not be worked hollow, with a view to making the joint perfect at the edges. A better plan is to work them flat, and insert a thin sheet of lead between them, cut a little smaller than the column itself, thereby leaving a small open joint all round, to be filled up with fine putty. Stone walls are usually measured by the perch of 21 superficial feet, of an assumed standard thickness of 18 inches, and therefore containing 31½ cubic feet; but sometimes the rod is used as a measure, as in brickwork, assuming however a thickness of 18 instead of 13½ inches.

Besides brick and stone, other materials are occasionally employed for the construction of walls, of which we may allude to flints and earth. Houses built of flints, which can only be used to advantage in certain localities where that material abounds, necessarily depend much for the cohesion of their walls upon the strength of the mortar, and on the judicious introduction of bonding courses of brick or larger stone, and of quoins or angles of the same. When well executed, the appearance of flint buildings is far from displeasing, and by a little management of the contrast afforded by the white outside and black centre of the flints may be made absolutely ornamental. Building with compressed earth, or building *en Pisé*, is a very cheap, simple, and when properly managed, durable mode of building, which has been long and extensively practised in some parts of France, especially in the neighbourhood of Lyon, and has been adopted in this country not only as a substitute for the rude plan of constructing cabins with mud tempered with straw, and held together by wattles and timber framework, but also in lieu of regular brickwork. In vol. xxvii. of the 'Transactions' of the Society of Arts, pp. 185-197, is a minute description, illustrated by a plate of the apparatus employed, of an improved mode of executing this kind of work, invented by Mr. Robert Salmon, of Woburn. The foundations, and the walls to a short distance above the level of the ground, are built of stone or brick, but all the upper part of the walls consists simply of earth, beaten or rammed into a compact mass between two boards, which are fastened in such a position that their inner surfaces correspond with the faces of the wall. The work proceeds in courses, and each course in portions of convenient length; and the boards, which serve as a mould, are so connected by bolts that they may be readily separated from one another, and from the completed portion of wall, and put together again in the required position for forming another portion of wall. The earth is thrown in in small quantities, so that every portion may be very completely beaten, and as it is thrown in, a little is drawn away from the surface of the mould, and its place supplied by a facing composition, consisting of about one-fourth lime and three-fourths of the earth used for walling, mixed together with water and slaked like mortar, but allowed to dry and pulverise before it is rammed in. This facing composition, which is applied about an inch thick, forms a cement-like face to the wall, and it preserves the earth from the access of moisture. When the surface of one course of earth has become hard before another is added to it, a little thick grout of lime and earth is added to facilitate the adhesion of the new and old work. Mr. Salmon observes that the earth for this work "should be neither sand nor clay, but partaking of both." "Clay," he adds, "is particularly objectionable, as is also chalk or calcareous earth of any sort. Sand is also not proper, unless accompanied with some binding quality: the bolder and coarser the sort of earth the better. When used, it should retain no more moisture than just to make it adhere together under the pressure of the thumb and finger." Earths containing a mixture of grit or fine gravel he considers generally the best. Bond-timbers, wall-plates, and all other pieces of wood inserted in the walls, are kept as thin as may be, to avoid settlement from shrinkage; and doorways and openings for windows may be conveniently formed by the insertion of temporary frames of stout planking, against which the earth is rammed as against the mould. In this mode of building labour forms the most important item of cost. At Woburn, with labourers at 1*s.* 10*d.* per diem, Mr. Salmon found the expense of a 16-inch wall to be about 2*s.* 8*d.* per superficial yard if faced and finished on one side only, and 3*s.* 4*d.* per yard if faced and finished on both sides; while the value of a superficial yard of brickwork, 14 inches thick, would have been more than 10*s.* at the same time and place. The walls may be finished externally by lime-washing, and, if intended to look very neat, by wetting and rubbing the surface with a plasterer's float, until it is smooth and even. A full account of the French mode of executing this kind of building is given in the sixteenth volume of the 'Dictionnaire Technologique' (8vo, Paris, 1829), art. 'Pisai, Pisè,' and in a briefer notice in the fourth volume of the 'Dictionnaire de l'Industrie' (8vo, Paris, 1795), article 'Murailles Economiques,' are some remarks respecting the meaning of the term *Pisé*, or, as it is sometimes written, *Pisè*. If the projection of the roofs be sufficient, and other precautions be taken to keep the walls dry, buildings of this character may be safely constructed of two or three stories in height, and they will prove very durable, many such buildings in France having stood more than a century without any symptom of decay.

Respecting the means of protecting walls from damp, whether arising from the foundation or not, some information is given under ASPHALTE. Double walls, in which a space is left between the external brick or stone wall, and the lining of the room of whatever kind it may be, are sometimes resorted to as a means of preventing the passage of damp, and a simple mode of producing the same effect,

which answers well when great strength is not required, is accomplished by the use of bricks laid on their edges instead of their flat sides. In a single brick or 9-inch wall of the ordinary construction there are no hollow spaces, because, the bricks being laid flat, the width of two stretchers, being 4½ inches each, is exactly equal to the length of the headers, that is to say, 9 inches. If, however, the bricks be laid on edge, but otherwise disposed in the same way, while the headers are, of course, of the same length, the width of the stretchers will be only 3 inches each, so that if they are laid to the face of the wall they will leave an intermediate space of 3 inches. Of course a less number of bricks will be required to produce an equal surface of wall by this than by the ordinary mode of laying.

Of the various departments of building relating to CARPENTRY and JOINERY brief notices will be given under those heads, with references to the various articles relating to them. Here it is only needful to observe that the portions of a building supplied by the carpenter should be so contrived as to strengthen and bind together the whole structure. The ROOF, especially, of which a full account is given under that head, should contribute greatly to the solidity of the building, as well as answer the primary purpose of a covering. In London houses, owing to the great value of space, sleeping-rooms are very often formed in roofs; and in certain cases, when the ridge of the roof is made parallel to the front of the house in order to secure as much internal space as possible, the front gutter is connected with that at the back of the house by a covered trough passing through the apartment formed in the roof, so that although the fall of water from the roof may be equal towards the front and back, the pipes for conducting the water to the ground may be confined to the back of the house. For the external covering of walls in which the brickwork is coated by a stone-like composition, see STUCCO; and for the lining of walls, the formation of ceilings, &c., see PLASTERING. Internal decorations are treated of under PAINTING, HOUSE, and PAPER HANGINGS. More specific information respecting the various parts of a building will be found in such articles as STAIRCASE, DOOR, WINDOW, ARCH, DOME, and CHIMNEY; and under FIREPROOF BUILDINGS, will be noticed some important deviations from the ordinary mode of building, in order to diminish the risk of fire.

BUILDING, ACTS FOR REGULATING. Provisions for regulating the construction of buildings are generally introduced into Acts for the improvement of towns. To permit houses of wood or thatched roofs in confined and crowded streets would be to sacrifice the public welfare to the caprice or convenience of individuals. There is no general measure ensuring uniformity of regulations for buildings throughout the country. In the session of 1841 the Marquis of Normanby, then a member of the government, brought in a bill "for the better Drainage and Improvement of Buildings in large Towns and Villages," but it did not pass; and a bill of a similar nature was unsuccessful in the session of the following year; and it was not until the Public Health Act, 1848 (11 & 12 Vict. c. 63), that a general provision was made for controlling the sewerage and drainage of towns. In the session of 1844, however, an act was passed (7 & 8 Vict. c. 84), entitled "An Act for Regulating the Construction and the Use of Buildings in the Metropolis and its Neighbourhood;" and this measure, though applicable only to London, was an important step towards improving the condition of large towns. It was amended two years afterwards, but was (with certain exceptions hereafter noticed) repealed by the Metropolis Building Act, 1855 (18 & 19 Vict. c. 122). London has had Building Acts ever since the reign of Queen Anne; but their object was chiefly to enforce regulations calculated to check the spread of fire. A Building Act, commonly called Sir Robert Taylor's Act (14 Geo. III. c. 78), was passed in 1774, "for the further and better regulation of buildings and party walls, and for the more effectually preventing mischiefs by fire." It extended to the cities of London and Westminster, and their liberties and other places within the bills of mortality, and to the parishes of St. Marylebone, Paddington, St. Pancras, and St. Luke's, Chelsea. The administration of the act was confided to district surveyors, each of whom had independent authority within his own district; but the magistrate at the nearest police-office might enforce or not, at his own discretion, the decisions of the surveyor. The technical regulations of this Act were many of them, generally speaking, of so impracticable a nature that their evasion was connived at by the officers appointed to superintend the execution of the law, and it did nothing to discourage the erection of imperfect buildings in districts which have become a part of the metropolis since it was passed.

The objects of the more recent legislation may be gathered from the preamble to the Act of 1844, which was as follows:—"Whereas by the several Acts mentioned in schedule (A.) * to this Act annexed provisions are made for regulating the construction of buildings in the metropolis, and the neighbourhood thereof, within certain limits therein set forth; but forasmuch as buildings have since been extended in nearly continuous lines or streets far beyond such limits, so that they do not now include all the places to which the provisions of such Acts, according to the purposes thereof, ought to apply, and

* These Acts are 14 Geo. III. c. 78, partly repealed; 50 Geo. III. c. 75, wholly repealed; and 3 & 4 Vict. c. 85, repealed so far as it relates to flues and chimneys.

moreover such provisions require alteration and amendment, it is expedient to extend such limits, and otherwise to amend such Acts: and forasmuch as in many parts of the metropolis and the neighbourhood thereof, the drainage of the houses is so imperfect as to endanger the health of the inhabitants, it is expedient to make provision for facilitating and promoting the improvement of such drainage; and forasmuch as by reason of the narrowness of streets, lanes, and alleys, and the want of a thoroughfare in many places, the due ventilation of crowded neighbourhoods is often impeded, and the health of the inhabitants thereby endangered, and from the close contiguity of the opposite houses the risk of accident by fire is extended, it is expedient to make provision with regard to the streets and other ways of the metropolis for securing a sufficient width thereof; and forasmuch as many buildings and parts of buildings unfit for dwellings are used for that purpose, whereby disease is engendered, fostered, and propagated, it is expedient to discourage and prohibit such use thereof: and forasmuch as by the carrying on in populous neighbourhoods of certain works, in which materials of an explosive or inflammable kind are used, the risk of accidents arising from such works is much increased, it is expedient to regulate not only the construction of the buildings in which such dangerous works are carried on, but also to provide for the same being carried on in buildings at safe distances from other buildings which are used either for habitation or for trade in populous neighbourhoods; and forasmuch as by the carrying on of certain works of a noisome kind, or in which deleterious materials are used, or deleterious products are created, the health and comfort of the inhabitants are extensively impaired and endangered, it is expedient to make provision for the adoption of all such expedients as either have been or shall be devised for carrying on such businesses, so as to render them as little noisome or deleterious as possible to the inhabitants of the neighbourhood; and if there be no such expedients, or if such expedients be not available in a sufficient degree, then for the carrying on of such noisome and unwholesome businesses at safer distances from other buildings used for habitation; and forasmuch as great diversity of practice has obtained among the officers appointed in pursuance of the said Acts to superintend the execution thereof in the several districts to which such Acts apply, and the means at present provided for determining the numerous matters in question which constantly arise tend to promote such diversity, to increase the expense, and to retard the operations of persons engaged in building, it is expedient to make further provision for regulating the office of surveyor of such several districts, and to provide for the appointment of officers to superintend the execution of this Act throughout all the districts to which it is to apply, and also to determine sundry matters in question incident thereto, as well as to exercise in certain cases, and under certain checks and control, a discretion in the relaxation of the fixed rules, where the strict observance thereof is impracticable, or would defeat the object of this Act, or would needlessly affect with injury the course and operation of this branch of business; now for all the several purposes above mentioned, and for the purpose of consolidating the provisions of the law relating to the construction and the use of buildings in the metropolis and its neighbourhood, be it enacted," &c.

By the present Act, the 18 & 19 Vict. c. 122, every building and work done upon it is subject to the supervision of a district surveyor, who is appointed and paid by the Metropolitan Board of Works, under the Metropolis Local Management Act (18 & 19 Vict. c. 120), the area of that Act being also the limits of the Building Act, comprising the parishes of St. Marylebone; St. Pancras; Lambeth; St. George's, Hanover Square; St Mary, Islington; St. Leonard, Shoreditch; Paddington; St. Matthew, Bethnal Green; St. Mary, Newington, Surrey; Camberwell; St. James, Westminster; St. James and St. John, Clerkenwell; Chelsea; Kensington (St. Mary Abbot); St. Luke, Middlesex; St. George the Martyr, Southwark; Bermondsey; St. George in the East; St. Martin in the Fields; Hamlet of Mile End Old Town; Woolwich; Rotherhithe; and St. John, Hampstead; with a power to the Queen in Council to extend the area under certain circumstances. The first part of the Act with its schedules relates to the "regulation and supervision of buildings, including alterations and additions, and provides for the structure and thickness of walls and their composition, roof, chimneys, accesses and stairs, rooms, passages, projections, and a variety of other matters securing ventilation, open spaces," &c. Part II. of the Act relates to "dangerous structures;" Part III., to "party structures;" Part IV. contains miscellaneous provisions as to the payment of expenses by owners, legal proceedings, &c.

The provisions of the previous Act (7 & 8 Vict. c. 84), for the restraint and eventual removal from populous neighbourhoods of trades which are dangerous, noxious, or offensive, are retained. By these sections businesses dangerous as to fire must not be nearer than fifty feet to other buildings; and new businesses of this character must be forty feet from public ways. Persons cannot establish or newly carry on any such businesses within fifty feet of other buildings or forty feet from public ways; and all such businesses carried on within the distances limited by the Act must be given up twenty years after the passing of the Act. A penalty of 50*l.* is incurred for erecting buildings in the neighbourhood of any such businesses, and 50*l.* per day for carrying on businesses of a dangerous kind contrary to the Act. The persons offending may be imprisoned for six months if the penalty be not paid. The businesses of a blood-boiler, bone-boiler, fell-monger, slaughterer of cattle, sheep, or horses, soap-boiler, tallow-melter, tripe-boiler, and any other business offensive or noxious, are subject to similar regulations as those deemed dangerous as to fire, and are to be discontinued at the end of thirty years after the passing of the Act. Trades deemed nuisances may be removed by purchase at the public cost on memorial by two-thirds of the inhabitants, and on the issue of an Order in Council. Public gas-works, distilleries, and other works under the survey of the Excise are exempted from the operation of some of these provisions.

"The Local Government Act, 1858" (21 & 22 Vict. c. 98), amending the Public Health Act, 1848, empowers every local board to make bye laws with respect to the following matters: 1, with respect to the level, width, and construction of new streets, and the provisions for the sewerage thereof; 2, with respect to the structure of walls of new buildings, for securing stability and the prevention of fires; 3, with respect to the sufficiency of the space about buildings to secure a free circulation of air, and with respect to the ventilation of buildings; 4, with respect to the drainage of buildings, to water-closets, privies, ash-pits, and cess-pools in connection with buildings, and to the closing of buildings, or parts of buildings, unfit for human habitation, and to the prohibition of their use for such habitation. The local board may also prescribe the line in which houses shall be rebuilt, making compensation to the owners for any loss or damage sustained in consequence of the building being set back. These powers are independent of various provisions for the prevention and removal of nuisances.

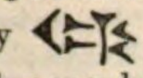
Scotland is under the operation of a peculiar statute passed in 1855, the 'Act to facilitate the Erection of Dwelling Houses for the Working Classes of Scotland.' Under certain conditions, and with the consent of the county and burgh authorities, four or more persons may unite for the purpose of building workmen's dwellings. They are to act as a joint-stock company with limited liability; and may appropriate the profits of their enterprise in the form of dividends. To ensure the carrying out of plans conducive to the attainment of the proposed end, all the proceedings of these companies are controlled to a certain extent by the sheriffs of counties, or the deans of burgh guilds. Each separate dwelling is to constitute a distinct lot, to consist of not less than two, nor more than five rooms with fire-places; each such lot or dwelling is not to be divided, but is to be held or transferred as an undivided whole. One of the most remarkable clauses in the Act is to this effect: "If any houses have fallen into a dilapidated or deserted state, and if a building company calls the attention of the authorities to this fact, the authorities may order the owner to rebuild or repair the houses in a proper way; and if he neglect to do so within three months the authorities may compel him to sell the property to the company for the purpose of being placed by them in proper condition, and at a price determined by means pointed out in the Act."

It may be here mentioned that the Building Societies, of which so large a number now exist in England, are based on the fact that the average rental of well-let houses is much higher than the average rate of interest on a given amount of capital. A man may in ten years pay as much money in the form of rental as the house costs to build. Hence the plan of *lending* him the money, at 5 per cent. interest, wherewith to build a house for himself; by paying a little more than the ordinary annual rental for a house of similar kind, he may in a few years pay off the whole of the debt, and become real owner of the house he lives in. The principle is probably a sound one; but it requires honesty and judgment on the part of the managers of the society. In some cases it has led to a species of speculation, not far removed from gambling.

BUILDING STONE. [STONE FOR BUILDINGS.]

BUL. The ancient name of a Jewish month, which is now called Marchesvan, or by abbreviation Chesvan. It was the eighth month, when the year began in spring, but after the transfer of New Year's day to autumn it became the second month; and in consequence of the variation of the lunar year, it may begin as early as the first week of October, or as late as the same period of November. The word is written בּוּל in Hebrew, and Βααλ, Βουαλ, or Βουλ, in Greek; and is derived from the verb נָבֵל *to fall;* the name was probably given from the season of the year when it occurred, as in our popular term "the Fall." This appears preferable to the usual explanation, "the rainy;" a passage in Isaiah, ch. xl. v. 7 8, נָבֵל צִיץ, "the flower fadeth," shows the precise kind of fall usually expressed by the verb; and moreover, this can hardly be called the rainy season in Palestine.

The name Bul is one of three which occur only in a very limited portion of the first book of Kings: Bul, in ch. vi. v. 38; Zif, in the same chapter, v. 1 and 37; and Ethanim, in ch. viii. v. 2. As these names, together with Abib, are the only ones in any part of the Bible written before the Captivity, while everywhere else months are designated by their numbers only, and as all these four terms have meanings which may relate to the seasons, it has been thought likely that they were merely such appellatives as we use when we say foggy month, or rainy month; but the very same words, *be yerach bul,* or "in the month of Bul," as we have in 1 Kings, vi. 38, above-mentioned, are found in the inscription upon the sarcophagus of King Ashmunezer, dug up in January, 1855, about a mile from Sidon, which proves its

use as a name; and it is curious, though possibly an accidental coincidence merely, that the second month in the ancient Assyrian calendars from Nineveh, now in the British Museum, which there are independent reasons for believing to correspond with the month under consideration, is written generally  a character which was certainly read *ul* or *val*. Sometimes the angular stroke at the left of the character was doubled, and sometimes omitted, but the sound was probably the same in all.

The names of the Jewish months now in use, include neither of the four above-mentioned; and any account of the fasts and festivals connected with these months will be given under their ordinary names.

BULI'MIA (*βουλιμία*), canine appetite, insatiable desire for food. The statement of the quantities of food consumed by some persons labouring under this disease is scarcely credible, yet it rests on testimony the veracity of which there is no reason to question. In the third volume of the 'Medical and Physical Journal' an account is given, by Dr. Cochrane of Liverpool, of a man placed under his own personal inspection, who, in one day, consumed of raw cow's udder, 4 lb., raw beef 10 lbs., candles 2 lb., in all 16 lb., besides 5 bottles of porter. M. Percy, a surgeon-in-chief to the French army, made a report to the National Institute of the case of a soldier who was in the constant habit of devouring enormous quantities of broken victuals, basketsful of fruits, and even living animals; the details given of the quality as well as of the quantity of articles consumed by this man, without ever satisfying his ravenous appetite, are too disgusting to be related. Dr. Copland gives an account of two cases of this disease, which occurred in his own practice in children, one seven years of age and the other nine. 'In both these, but in the younger especially, the quantity of food devoured was astonishing. Everything that could be laid hold of, even in its raw state, was seized upon most greedily. Besides other articles an uncooked rabbit, half a pound of candles, and some butter, were taken at one time. The mother stated that this little girl, who was apparently in good health otherwise, took more food, if she could possibly obtain it, than the rest of her family, consisting of six besides herself. In both this and the other case the digestion seemed to be good. A nauseous smell emanated from the bodies. These children, who were both very intelligent, complained of no other uneasiness than a constant gnawing or craving at the pit of the stomach, which was never altogether allayed, but which, shortly after a meal, impelled them irresistibly to devour everything that came in their way, however disgusting."

The real nature of the morbid condition of the stomach and of the system in this disease is very imperfectly known. In several cases the health in other respects has appeared good, but in most cases there has been evident disease in various organs, and death has usually taken place at an early age. On the examination of the body after death the stomach has commonly been found enormously distended and sometimes misplaced; the duodenum and the rest of the intestines are usually in the same state of distension; the coats of all these organs are commonly thickened, and the valvulæ conniventes (the folds of the inner or mucous membrane of the intestines) as large as in carnivorous animals. Various organic changes have at the same time been found in the mesentery and its glands, as well as in the liver, the pancreas, and the spleen.

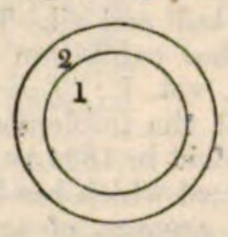
There can be no question that most cases of this disease might be greatly mitigated, if not wholly removed, by the firm and constant restriction of the food to that quantity only which the wants of the system really require. Unless the individual have strength of mind to submit to the necessary privation, or unless, in the case of children, a steady and undeviating restraint be imposed, every attempt to remedy the evil will be vain. If a rigid regulation of the diet be enforced, the cure will be materially assisted by a course of nauseating purgatives, as oil of turpentine rendered more active by castor oil. Several cases of great intensity have been completely cured by a steady treatment conducted on these principles.

When inordinate appetite is merely the result of some other unusual or morbid condition of the system, that is, when it is what is called symptomatic; when, as is often the case, it is the consequence of great fatigue, or of inanition, from long-continued acute disease, or of some malady attended with an extraordinary degree of secretion and excretion, and therefore with the removal from the system of a proportionate quantity of its nutrient matter, the disease can be cured only by the restoration of the system to its ordinary and sound state.

BULL-FIGHTS, a very ancient and barbarous amusement, which, under different modifications, has descended to modern times, and is found in many of the countries of Europe, though the English form of it (bull-baiting) may almost be said to have gone out of fashion.

Bull-fights were known to the ancient Egyptians; and also to the Greeks more than 300 years before Christ. The Thessalians had their regular festivals or days of bull-fighting. As the Thessalians were celebrated for their skill in horsemanship, it is probable their combats resembled those of the Spaniards, the most celebrated of modern bull-fighters, and the only European people that have preserved the sport in its perfection. It appears to have been introduced by the Moors, who are generally said to have introduced it with the djerid and other equestrian and warlike sports into Spain in the 8th century. Originally it gave occasion to a display of clever horsemanship, dexterity with the lance, and personal courage, when high-born cavaliers were the combatants; but when, on the accession of the Bourbons to the throne of Spain, it ceased to be patronised by the court, it became unfashionable, and was only maintained by the popular interest in its favour; and being so left, it soon became vulgarised, and the professional actors, like the boxers of our prize-ring, are now of a low class, though occasionally patronised by those of a higher class, particularly since the sport has again been sanctioned by the presence of the sovereigns. Though disgusting from the quantity of blood of bulls, horses, and men that frequently flows in the arena, a true Spanish bull-fight like those exhibited at Madrid, Seville, Cadiz, and the great cities of the south, is a gallant and imposing spectacle. It has often been described in prose and verse. In the first canto of Lord Byron's Childe Harold, there is a description of one at Cadiz, which is not more poetical than it is correct. A few words in plain prose may convey some notion of the game, to which Spaniards of both sexes and of all ranks are passionately attached.

The amphitheatre, or plaza de toros, in the great cities, is an extensive edifice, partly built of stone and partly of wood; it is open at top, with seats running round it and rising above each other, and is capable of accommodating from 5000 to 10,000 spectators. The lower tier of seats is protected by a parapet, in front of which a very strong wooden fence, about six feet high, is erected; this fence runs (like the seats) all round the arena, at the distance of from twelve to twenty feet from the lowest tier of seats. The ground-plan of the plaza thus describes two circles; No. 1, or the inner circle, being the battle-ground, and No. 2, or the outer circle, being the place where the men on foot take



shelter when hard pressed by the bull. To allow of the latter movement, openings just large enough to admit a man sideways are made in the strong fence which separates the two circles.

The actors on the arena are, first, the bull, which ought to be of the fierce Andalusian breed; second, the picadores, or men who attack the bull on horseback; third, the banderilleros, who attend on the picadores, and are armed with sharp goads furnished with coloured streamers; fourth, the chulos, or men with glaring coloured cloaks, with which they distract the bull's attention; and fifth, the matador, who directs most of the movements, gives the bull his finishing-stroke, and who, in reality, may be considered as the chief performer. Each matador, as well as each picador, has generally two chulos attached to his person. When all is ready, there is a flourish of trumpets; then the picadores, with lances in rest, caracole within the barricade, and the banderilleros and chulos, in their old Spanish and bespangled dresses, step lightly into the arena. The trumpets sound again—the combatants take up their places, and all is quiet in the amphitheatre. Another flourish, and the bolts of the bull-stall are withdrawn, the gate in the barrier is thrown open, and the spectators shout El toro! (the bull!) who, if he be a good one, gets into the midst of the arena at a single bound. The picadores await his furious onset, their object being to wound him with the lance, and then give him the go-by, avoiding the shock of his charge, which is sometimes fatal both to man and horse. Generally speaking, however, the horses used for the sport are of the most miserable description; and the skill of the rider is only shown in exposing the horse to the attack of the bull, while he avoids it himself. The horse is frequently gored, yet succeeds in bearing his rider away in safety, then drops, and is hauled out of the arena, "No vale na" (he is worth nothing) being the reply to any expressions of pity for his fate. When any picador is closely pressed, the footmen, both banderilleros and chulos, rush to his assistance, and, by pricking him with their darts, and waving their red, scarlet, and yellow scarfs before his eyes, nearly always succeed in drawing off the bull's attention. These attacks and defences are repeated until successive wounds from the lance and the shorter goads of the banderilleros cause the poor bull's flanks and shoulders to stream with blood. At first these wounds madden him, but the loss of blood and his furious exertions gradually weaken and dispirit him. In most approved bull-fights, at a certain stage, the picadores or horsemen withdraw, and leave the combat to the banderilleros, each of whom carries a banderilla or dart, about two feet long, ornamented with a pennant, in each of his hands, but no cloak, or dazzling scarf of any kind on his arm. Thus armed, the banderillero runs up to the bull, and stopping short when he sees the animal's head lowered to attack him, he fixes the two shafts, without flinging them, behind the horns of the bull, at the very moment that it is preparing to toss him. The pain thus occasioned makes the bull throw back his head and lose his blow, on which the nimble-footed banderillero retreats, one of his comrades comes up to the charge, or a chulo throws a cloak over the bull's horns, and so, by blinding it, prevents the renewal of the combat for some seconds. Should the banderillero fail in fixing his darts, and should the bull be still fresh, he must rush to one of the openings left in the wooden fence, and creep

into the outer circle. The nimblest of the banderilleros, instead of seeking the opening, which may be too distant for them to make in face of the bull's horns, will lay their hands on the top of the fence and spring over it; and a fine bull of the true breed has sometimes been known to go over after them, clearing the six-feet fence as an English hunter takes a five-bar gate.

At length, bellowings of rage and pain, and his wavering, uncertain onsets, show that the poor bull's death is near. Then a great man in the privileged government boxes waves his handkerchief, and another flourish of trumpets gives the signal to the matador to come forward and do his last office. Followed by some chulos as auxiliaries and assistants, the matador advances with a red mantle, or a piece of red cloth attached to a short handle, in his left hand, and a long, well-proved sword in his right. He first of all drops on one knee in front of the royal or government box, doffs his cap, asks permission to finish the affair, draws his arm across his breast to the right and left, throws down his cap as a pledge which he must redeem, and then rises to do his work. The perfection of his performance consists in this—he must wait the bull's charge, his person being partially, and his toledo blade wholly, concealed behind the extended cloak, and he must so receive the bull on its point that the sword shall penetrate up to the hilt in that particular part of the animal where neck and shoulders meet. When this happens, the bull staggers for a second or two, and then drops in the midst of the enthusiastic shouts of men, women, and children. As soon as the bull is dead, and sometimes before, another blast of trumpets is heard, and four powerful and richly-caparisoned mules, with large bells round their necks, and harnessed abreast, trot into the arena. Their traces are hooked to a cross-bar, which is attached to the bull's horns; trumpets are sounded and hands clapped, and away gallop the mules, bull and all. The barriers are again closed, and the lists ready for another exhibition of torture and blood. (See Ford's *Handbook of Spain*, vol. i.; *Tauromaquia*, a series of thirty engravings, representing all the implements, costumes, and different operations, published at Madrid in 1804.)

BULLETIN, a French word which has been adopted by the English to signify a short authentic account of some passing event, intended for the information of the public. Bulletin is derived from *bulla* a sealed despatch. (Ducange, 'Glossarium.') When kings and other persons of high rank are dangerously ill, daily bulletins are issued by the physicians, relative to the state of the patient. In times of war, and after a great battle, bulletins are sometimes issued from the head-quarters of the victorious army, and are sent off to the capital to inform the people of the success.

BULLETS. The general mode of making bullets is noticed under SHOT-MANUFACTURE; but a few special methods may be adverted to here. A patent for making bullets was taken out in America in 1849, in which the bullet is formed by punching. The end of the punch has a hemispherical cavity, and a die is used which has a similar cavity. A strip of sheet lead is laid on the die, and the punch is brought down upon it with a force sufficient to sever a small piece of lead, and to form it into a globular shape by means of the two hemispherical cavities.

Several years before, however, in 1840, Mr. David Napier had patented a method, somewhat similar in principle, but more comprehensive, for making bullets in which great accuracy of form may be required. The machinery consists of two sliding plungers, placed horizontally and opposite to each other, each carrying a hemispherical die. The meeting and closing of the two dies give a perfectly spherical form to any substance compressed between them. In the centres of these plungers are two sliding plugs, which, in the retrocession of the plungers, are urged forward by a spring placed behind them, and drive out the compressed ball. An alternating motion backwards and forwards is given to the plungers. Strips of lead having projections, prepared either by rolling or casting, are supplied to the machine, the continuous pressing of which converts the projecting pieces of lead into perfect spheres, held together by a thin film of lead. The strips are then taken to a small hemispherical punch, working vertically into a circular bed the same size as the balls; and on bringing down this punch by means of a foot treadle, the balls are cut out, fall through the bed, and roll down a trough into a proper receptacle. This method of making bullets by compression was at one time adopted by the government at Woolwich Laboratory, the apparatus being worked by steam.

A proposal has been made to construct bullets of lead wire, by coiling the wire upon rests, so arranged as to allow the wire to be fed downwards into a machine, where it can be measured or gauged, cut off to the proper lengths, and compressed by forcing through a die or dies.

The Ordnance estimates for 1857–8 contained an entry of 1000*l.* paid to Mr. Greener, the gunmaker of Birmingham, for his invention of a peculiar expanding bullet to be used with rifles.

The more curious and complicated forms of bullet, such as that just adverted to, will be best described in connection with the remarkable weapon to which they chiefly belong. [RIFLE.]

BULLION, a term used in political economy, and particularly in relation to questions of currency and banking, to denote the precious metals gold and silver in their raw state, or, more properly, as they came from the refiners, and before they are coined or otherwise manufactured. This is the proper sense of the word, but it is very commonly applied, in speaking of exportation, to include either coined gold or coined silver. For details of the early use, as a medium of exchange, and of the modern application of gold and silver to the purposes of currency, the reader is referred to Jacobs' 'Historical Enquiry into the Use and Consumption of the Precious Metals;' Baron Humboldt's 'Essai sur la Nouvelle Espagne' may be consulted for accounts of the modes of extracting silver from the mines of South America, whence the principal supply is derived to Europe, with estimates of the quantities exported thence since the beginning of the 15th century, &c.

Full accounts of the late discoveries of gold in California and in Australia, New South Wales, and Victoria, will be found under those heads in the GEOGRAPHICAL DIVISION of this work. Very considerable supplies of gold have been obtained, of late years, by the Russian government from the mines of the Ural Mountains.

All nations, with very few exceptions, as they emerge from a rude state of society and manners, have been found to adopt bullion as a means, more or less exclusively applied, for exchanging products and supplying man's wants; and bullion has peculiar fitness for serving the purposes of a medium of exchange or money; for these reasons:

1. Bullion, whether in its form of gold or of silver, has the property both of being divided into small portions and of having those portions re-united, without in either case suffering any sensible loss of intrinsic value: thus a given quantity of bullion may be easily made to represent values proportioned to the prices of a corresponding quantity of articles of purchase for which it is required.

2. Bullion is the same in quality all over the world; an ounce of pure gold dug in the Ural Mountains is exactly similar to an ounce of pure gold taken up in Australia; an ounce of pure gold extracted from the earth 100 years ago is of precisely the same quality as an ounce of pure gold got yesterday. Exposure to weather, the scorching sun, or the rigour of frost, produces no deterioration of its quality. From all which it follows, that the relative weight of any portion of it determines at once its relative quantity and value to every other portion. Two ounces of gold are worth exactly twice as much as one.

3. Bullion, in each of its kinds, when properly treated,—that is, with a proper mixture of alloy,—is hard enough to resist friction, to a very considerable extent, for a great length of time. Moreover, it is not liable to corrode or rust, and therefore is fitted for the purposes of a circulating medium, as both kinds may be so prepared as to be capable of passing from hand to hand for the purposes of trade and commerce, and of being carried about in the shape of coins for lengthened periods without sensible diminution from abrasion.

4. Bullion is not so rare an article, and therefore not so dear, as to produce the consequence, that the quantity of gold or of silver equivalent to a given quantity of commodities, is in general so small as to be inconvenient. It is not found therefore in practice necessary to coin gold or even silver into such minute pieces, in order to serve the purposes of the vast majority of transactions, as to be easily liable on that account to loss. On the other hand, bullion is nowhere so abundant, and therefore so cheap, as to make it necessary to carry about, with you, anything more than a very moderate weight of it, in order to answer the ordinary purposes of the purchase of commodities, or the effecting of payments. A solid cube of a little more than five inches of gold contains the value of 10,000*l.*

5. Bullion, in both kinds, is capable of receiving and retaining, for long periods, stamps, impressions, characters, &c., by which the weight, the degree of purity, or the value in exchange of each coin may be certified, as may be necessary according to the habits of the nation in which it is to circulate. The alloy spoken of above as being mixed with coined bullion, consists usually of copper, which is introduced for the purpose of adding hardness to the piece, the value of the baser metal thus incorporated being reckoned for nothing. By this is not meant that the alloy is in itself valueless, but, inasmuch as the operation of disuniting it from the pure bullion would cost more than the value of the base metal after it was extracted; for this reason, a piece of gold or silver bullion in a coined shape, and therefore mixed with alloy, is estimated in currency by the quantity of the precious metal only which is contained in it.

But besides its employment for the purposes of coined money, and for decoration, for personal ornament, for plate, domestic utensils, and other uses, bullion has another very important use, as an international medium of exchange; and when employed in this way it is usually, though not always, formed into bars or small blocks. If, as the result of a given period of trading transactions between two countries, as France and England, it is found [the mode of ascertaining the result will be fully explained under EXCHANGES] that France has imported from England commodities, to a greater value, than England has imported from her, there will be a number of merchants in England whose correspondents in France will owe them the price of the English goods which have been sold into France; and these debts it will not be possible to settle by means of bills of exchange, drawn on persons residing in England, and payable here, because, on the whole, there will be nothing owing from the English side to the French side. In such case therefore it becomes necessary for the French debtor to look out for some commodity that is in general request, and which there-

fore mostly finds a ready market all over the civilised world, and to send so much of that commodity into England as may, by its sale there, realise such a sum as will pay his debt there. The commodity, of all others, best conforming to this condition is bullion, for which, owing to its adaptation to many purposes and its supplying many wants, real or imaginary, there is always a steady demand in commercial emporiums. The French debtor therefore buys the requisite quantity of gold or silver in bars (sometimes called *specie* in commerce) and transmits it to England in time to pay his debt at the expiration of the credit that has been given him. Thus bullion acts as a medium of international exchange, and performs a most valuable service to society.

In England, bullion, and chiefly bullion in bars, discharges another function of vast importance, as the basis of the paper currency, so far as that currency consists of the promissory notes of the Bank of England, which are practically equivalent, for all the purposes of money, to gold and silver coins, being made by law a legal tender at all places and in payment of all debts and purchases, except at the Bank of England and its branches. [See further, BANKING; CURRENCY.] By the expression that bullion is the basis of the Bank paper currency, is meant, briefly, that there must always be a certain proportion maintained between the value represented by the Bank of England notes that are issued and outstanding in the hands of the public, and the value of the bullion which the Bank has in its possession in its vaults in Threadneedle Street, London. This is fully explained in that part of the article BANKING which treats of the Bank of England.

At the Mint, gold bullion of the standard fineness is bought at an uniform price of 3*l.* 17*s.* 10½*d.* an ounce; and the meaning of the expression is, that in return for 40 lbs. of gold the Mint gives 1869 sovereigns, or pieces of equal fineness, weighing 40 lbs. (See 'Edinburgh Review,' Oct. 1846, p. 328.) No seignorage is charged for this service.

At the Bank of England, all standard bullion offered for sale is bought; it is not discretionary with them whether they will buy or not; that is to say, as any person taking the proper quantity of gold bullion to the Mint may have it coined into a sovereign, so any person taking five times that quantity of gold bullion to the Bank may obtain a 5*l.* Bank of England note for it. Or in other words the Government are bound by law, through the issue department of the Bank of England, to do what is practically to coin into 5*l.* notes all the gold and silver that is offered for sale there. ('Evidence before Committee of House of Commons, 1858, on Bank Acts, &c.,' pp. 144, 147, 148, 153, 155, 186, 187, 191.)

In practice it is considered to be somewhat more desirable, for the importer of bullion, to take it to the Bank than to the Mint, because at the latter he must wait for the payment of the price until the bullion can be coined into sovereigns or silver money as the case may be, thereby losing interest; at the former he receives the payment immediately in Bank notes, the Bank charging only a commission of one penny per ounce. But there does not appear to be much ground for the preference of the one mode of exchanging the bullion over the other, as it is probable that the loss of interest, by the delay at the Mint, is pretty accurately measured by the charge for commission made at the Bank. However, these two modes being open to him, the law gives to the importer of bullion a perfect freedom, without the leave of anybody, to convert his commodity into one or other of the circulating mediums—either the metallic or the paper currency—of the country, as he pleases, at an extremely small cost.

The bullion thus obtained by the Bank of England, in ordinary periods of trade and commerce, is found to accumulate, and frequently it has risen to very large amounts. On the other hand, all panics or periods of pressure and stagnation and want of confidence in the commercial body of this country, have been observed to be preceded by a continuous drain of the bullion out of the coffers of the Bank, arising from bullion being in demand for exportation. The panics of 1783, 1793, 1795, 1797, 1816, 1825, 1836, 1840, 1847, 1857, were each of them preceded by such a drain. The exports of the precious metals in the course of 1825 repeatedly, it has been stated, amounted to a million sterling a month. Hence the state of the bullion in the Bank, as shown in the periodical returns of its state which the Bank is by law obliged to publish, furnishes a criterion of the state of commerce, and of the money market, of great value to bankers and merchants; enabling them, to a considerable extent, to be early aware of the approach of a season of pressure and failure of confidence, when there will be a demand for the legal tender in payment of debts, and to make their preparations accordingly. This is done by converting outstanding securities into money and Bank of England notes, by reducing the number and magnitude of their transactions, and by other measures. Bullion, therefore, in this point of view, is closely connected with questions of currency and commercial prosperity. [CURRENCY.] It has been supposed that the obligation upon the Bank of England to give their notes for all the bullion that may be offered to them, whether they want it or not, had an effect, by increasing beyond the wants of the country the circulating medium, to depress the current rate of interest, and so cause British capital to seek investment in countries, such as America, where higher interest was, and sometimes in the event fallaciously, held out; but the highest authorities on the subjects of circulation, the money market, and commerce, are confidently of opinion that no part of the cause of the low rate of interest, which sometimes prevails

in this country, is to be attributed to this source. Perhaps this question deserves further investigation; because, whatever tends materially to depress the rate of interest has been shown, by modern experience, to be a source of evil upon the whole; it not being in these times true, as perhaps it might have been according to the experience of the less speculative times in which David Hume wrote, that "Interest is the barometer of the state, and its lowness is a sign, almost infallible, of the flourishing condition of a people." ('Essay on Interest.')

Until of late years, there was no means of ascertaining the quantities of bullion imported and exported in this country; the official tables not taking notice of transactions in specie. (Hamilton, 'Progress of Society,' p. 315.) Now (1859), however, it is otherwise; and the following table, which was prepared by the authorities of the Bank of England in 1858 for the use of the Committee of the House of Commons named above, gives an interesting view of the additional supplies of the precious metals which have been poured into Europe. In 1849, the newly-discovered gold mines of California began to add perceptibly to the arrivals of gold in Europe; in 1851, the supply was increased by the still more fertile discoveries in Australia, &c. The result is this:—

ESTIMATED INCREASE OF THE EUROPEAN STOCK OF BULLION IN SEVEN YEARS.

	Imports from the producing Countries.		Exports to the East from Great Britain and the Mediterranean.	
Years.	Gold.	Silver.	Gold.	Silver.
	£	£	£	£
1851 . .	8,654,000	4,076,000	102,000	1,716,000
1852 . .	15,194,000	4,712,000	922,000	2,630,000
1853 . .	22,435,000	4,355,000	974,000	5,559,000
1854 . .	22,077,000	4,199,000	1,222,000	4,583,000
1855 . .	19,875,000	3,717,000	1,192,000	7,934,000
1856 . .	21,275,000	4,761,000	479,000	14,108,000
1857 . .	21,366,000	4,050,000	529,000	20,146,000
	£130,876,000	29,870,000	5,420,000	56,676,000

Thus the total import of gold in the seven years may be put at 130 millions sterling; the exports of gold bullion and British gold coin to India, China, Australia, the Cape of Good Hope, Brazils, West Indies, United States of North America, &c., may be taken at 22½ millions; leaving an increase in the European stock of gold bullion of 107½ millions sterling. Then the imports of silver from the producing countries in the same seven years being 29,870,000*l.*, and the exports to India and China, 56,676,000*l.*; make the quantity of silver withdrawn from the European stock to be 26,800,000*l.* Therefore, on the whole, the estimated increase on the stock of European bullion is equal to 80,700,000*l.* ('Companion to the Almanack,' 1859, p. 170; 'Report of Committee on Bank Acts,' 1858, pp. iii., iv.)

It may be worth noting, however, that from 1810 to 1833 the supply of the precious metals was considered to have decreased to an extent unknown for three centuries previously;—according to Jacob, at a rate not less than 20 per cent.; and in proportion as the European and American trade with India and China increases, the stock of silver bullion may be expected to decrease in Europe, because that trade, to a great degree, is carried on by means of silver; that is, instead of exports from the East being paid for in European or American manufactures, the returns for the most part are made in silver bullion. Therefore, until a change takes place in the habits of the people of China and India, causing a demand for the articles in general demand among more advanced and civilised populations, and in the absence of an increase in the average supplies of silver from the mines, the stock of it in Europe must necessarily diminish.

The increase in the uses to which bullion, especially gold bullion, has been applied of late years in this country is very perceptible. Gold is much more extensively and generally used for plate, in the making of watch and pencil cases, spectacles and eye-glasses, earrings, studs and buttons, &c., and much oftener met with in the shape of trinkets and articles of bijouterie, than formerly. The gold consumed in gilding at Birmingham alone is worth 50,000*l.* annually. (Whately, 'Lectures on Polit. Econ.,' p. 156.) Also, the quantity of bullion thus employed never suffers any perceptible diminution; because, in general, articles of plate, ornament, bijouterie, and trinkets are not melted down when the price of bullion in the general market is high, with the intention of replacing them when bullion falls: it is found by experience that the cost of manufacturing is such as to prevent that: over and above the consideration that a peculiar pride is felt in the possession of such articles, which causes, in most persons, a strong reluctance to part with them. Hence the quantity of bullion which is employed in the forms of decoration and ornament, and generally in application to the arts, in any of the civilised countries of the world, would supply a kind of test or measure of the wealth of the country; because it is, in ordinary times, subject to no variation except that of increase: but there are no means of ascertaining the quantities of bullion thus used.

Nor is it more practicable to ascertain the amount of bullion which is in the hands of the people, in this country, at any given time; because large proportions of the metallic, especially the gold, currency, are at times withdrawn from the circulation in order to be exported as bullion, when the state of the exchanges renders such exportation profitable. [EXCHANGES.] It may however be interesting to see the amount

of gold and silver coins issued during the year 1857, the last for which we have the account :—

Gold.	Value.
Sovereigns	£4,495,748 4 10
Half Sovereigns	364,111 17 4
Total gold	£4,859,860 2 2

Silver.	Value.
Florins	£167,112 0 0
Shillings	128,106 0 0
Sixpences	55,386 0 0
Fourpences	69 6 0
Threepences	22,034 2 0
Twopences	39 12 0
Pence	33 0 0
Total silver	£372,780 0 0

('Companion to the Almanac,' 1859, p. 169.)

Still more difficult must it be to arrive, upon reasonable grounds, at an estimate of the value of the bullion in circulation, in the shape of coined money, throughout the world. Nevertheless, such calculations have been made by various political economists; of these, the following are perhaps the most trustworthy. The quantity of coined money in the world has been estimated thus :—

By Storch, . at 221 millions sterling.
„ Humboldt, „ 325 „ „
„ Jacob, „ 380 „ „

BULLS, PAPAL. Letters issued from the papal chancery, and so named from the *bulla* or leaden seal which is appended to them. The difference between bulls, briefs, and other Apostolical rescripts, is noticed under the word BRIEF. Bulls are written on parchment. If they regard matters of justice, the seal is affixed by a hempen cord; if of grace, by a silken thread. The seal bears, on the obverse, heads of St. Peter and St. Paul: on the reverse, the name of the pope, and the date of the year of his pontificate. In France, in Spain, and in most other kingdoms professing the Roman Catholic faith, bulls are not admitted without previous examination. In England, to procure, to publish, or to use them, is declared high treason by 13 Eliz. c. 2. The name Bull has also been applied to certain constitutions issued by the emperors. In affairs of the greatest importance bullæ of gold were employed, whence they were called Golden Bulls.

Eleven folio volumes, published at Luxemburg, between 1747 and 1758, contain the bulls issued from the pontificate of Leo the Great to that of Benedict XIV., from A.D. 461 to A.D. 1757. The two most celebrated among them are, that 'In cœnâ Domini,' which is read every year, as these words imply, on the day of the Lord's Supper (Maundy Thursday): it denounces various excommunications against heretics and other opponents of the Romish see: and the bull 'Unigenitus,' as it is called from its opening words, "Unigenitus Dei, filius," issued by Clement XI. in 1713, condemning 101 propositions in Quesnel's work, or in other words, supporting the Jesuits against the Jansenists in their opinions concerning divine grace.

The most remarkable Imperial Bull is that approved by the Diet of the Germanic empire in 1356, in which Charles IV. enumerated all the functions, privileges, and prerogatives of the electors, and all the formalities observed in the election of an emperor, which were considered as fundamental laws till the dissolution of the Germanic body in 1806. We believe that the Latin original is still preserved at Frankfort with the golden seal, or *bulla*, from which it derives its name, appendant to it.

BUOYANCY is the power which certain materials have of being supported at the surface of a fluid so as to sink in it as much only as a part of their depth or thickness; thus ice, some woods, &c., are said to have buoyancy in water. Almost all solid bodies have the power of floating on mercury. The term is frequently used to designate the weight by which a solid mass of wood, or a vessel of wood or metal, can be made to sink in water till its upper surface is on a level with that of the water, or till a horizontal section of the body, at a given distance from the upper or lower surface of the latter, is on that level.

It is shown [HYDROSTATICS] that, when a body is immersed in a fluid, the weight of the body with whatever it may carry is equal to the weight of as much of the fluid as is equal in volume to the immersed part of the body. Hence, if the specific gravity of a body and that of a fluid are given (the former being less than the latter), the buoyancy may be found. Thus, by the rules of mensuration, find in cubic feet the volume of the body, if it is to be wholly immersed, or the volume of the part only which is to be under water, and multiply it by the specific gravity of water (the weight of a cubic foot of the fluid), the product will be the weight of the water displaced: subtract from this product the weight of the body, and the result will be the required buoyancy, or the weight which it will carry without sinking lower than the given depth. If the body, suppose it to be a log of timber, cannot be actually weighed, the product of its volume by its specific gravity will express its weight.

If it be required to find the volume of a rectangular mass of timber, of given depth, which will support a given weight, the following equation may be formed :—

Let s be the unknown area of a horizontal section through the mass of timber, and consequently the horizontal surface of the displaced water. Let d be the given depth of the mass of wood, and d' the given depth to which it is to be immersed. Let g be the specific gravity of the wood, and g' that of the water; also let W be the given weight which is to be supported:

$$\text{Then } s \times d \times g + \mathrm{W} = s \times d' \times g';$$

$$\text{whence } s = \frac{\mathrm{W}}{d'g' - dg}$$

and this value of s being multiplied by d, will give the required volume.

In a similar manner may the buoyancy of casks or other vessels be found, or the number of vessels which would be required to float any given weight; the volumes being found by the rules of mensuration, and the weight of a vessel by experiment or by the volume and specific gravity of its solid part.

This proposition is useful in determining the amount of volume which would have buoyancy sufficient to raise a sunken ship, or in determining the dimensions of a floating bridge which may support a given weight of troops or artillery.

As regards a ship, the calculation of buoyancy is by Sterling's rules [STERLING'S RULES] reduced to a very simple formula. It will be sufficient however here to mention some interesting facts connected with the subject of buoyancy.

To the uninitiated, the circumstance of the absolute *weight* of a ship of war being known must appear a difficulty; not so however to the naval architect. The above equation shows that weight may be as readily ascertained by *measurement* as by *experiment*. Hence we find (Peake) that a man-of-war of 120 guns, with stores and equipments to load water-line, and which no human means could easily place "in the balance," weighs 4760 tons—the mere hull weighing 2462 tons, as seen in the following tabular arrangement :—

Rate of Ship.	No. of Guns.	Weight in Tons of						
		Guns.	Anchors.	Cables.	Masts and Yards.	Hull.	Material received on Board.	Ship and Stores.
1st	120	273	20	86	64	2462	2208	4760
2nd	84	203	17	75	63	1559	1762	3721
3rd	74	156	14½	66½	45	1600	1428	3028
4th	50	131	14	51	46	1308	892	2200
5th	42	72	9½	31½	27	760	832	1592
6th	26	48½	7½	24½	22½	510	450	960
Sloop ship-rigged	18	16	4½	15½	10			480

Such are (or rather have hitherto *been*) the buoyancies or displacements of the different classes of her Majesty's ships; but a vast change is in progress. Naval architecture must henceforth conform more absolutely to the improvements suggested by the use and development of steam-power. The question of projectiles [GUNNERY], now only dawning upon the world, as experiments increase in number and interest, must also greatly modify the form of ships, and render the consideration of "buoyancy" of still more importance to Great Britain as a nation, inasmuch as the change of material in substituting "*plates*" *of iron* for planks of oak will effect a total revolution in the "lines" and floatation of ships. [SHIP.] The subject, so congenial and important to Englishmen, will be treated in this Cyclopædia accordingly.

Since the year of the Great Exhibition in Hyde Park, the consideration of "buoyancy" has been more prominently before the public from the attention drawn towards it in the investigation of the qualities of various forms of life-boats. Such investigation resulted in the production of a boat which is now known as Peake's life-boat, and is extensively used on the coast. [LIFE-BOAT.] But, whatever precautions may be taken for the *general* safety of a crew, it is notorious, that the encouragement given by the Shipwrecked Mariners' Society to fishermen and mariners to avail themselves of the means of "individual buoyancy" is met with indifference, and hundreds of lives are consequently lost yearly. The lamentable effects of this professional prejudice are to be seen in the number of widows and orphans at all our sea-ports and fishing villages, stretching to a mere comparative film the benefits which the funds of the Shipwrecked Mariners' Society might otherwise annually effect, and paralysing its praiseworthy endeavours to alleviate, by the weightier and more concentrated distribution of its humane and seasonable assistance, the misery which appeals so loudly to our sympathies.

(Peake's *Ship-Building*; *Shipwrecked Mariners' Magazine*, &c.)

BUOYS,—French, *Boues*; German, *Ankerboyen*; Dutch, *Ankerboeien*; Danish, *Ankerbojer*; Swedish, *Ankerbojor*; Italian, *Gavitelli*; Spanish, *Boyas*; Portuguese, *Boias*. Until the 36th year of Queen Elizabeth all public buoys in this kingdom were under the management of the Lord High Admiral, but in that year (1594) the queen, by a warrant dated 11th of June, granted to the corporation of the Trinity-house of Deptford-

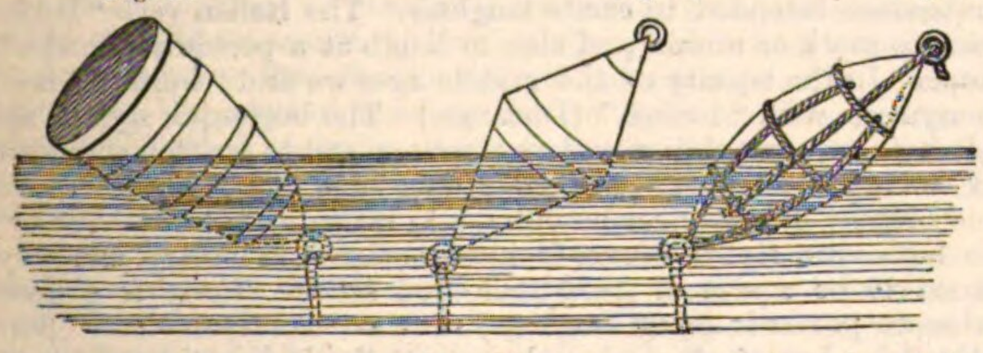
strond the right of "making, erecting, setting up, placing, or laying out, all buoys, beacons, marks, and signs for the sea or sea-shore, to hold the same with all profits and emoluments thereunto belonging, as of the manor of East Greenwich, in free and common soccage." On laying down any public buoy, the officers of the Trinity-house corporation give notice to the public of its form, colour, and exact situation, and of the reason for its being laid down; and notifications are also made upon their removal, whether the same arises from design or through accident. By the acts 6 Geo. IV. c. 125, and 17 & 18 Vict. c. 104, it is provided, "that every person who shall ride by, make fast to, or remove, or wilfully run down or run foul of any vessel placed to exhibit lights, or any buoy or beacon belonging to, or placed by, any corporation or society having lawful authority to place the same, shall, besides being liable to the expense of replacing or making good any damage occasioned thereby, forfeit for every such offence any sum not exceeding 50*l.* nor less than 10*l.*" The amount of revenue annually collected for the use of buoys by the Trinity-house corporation is according to the tonnage of the vessels frequenting the ports in or leading to which buoys are placed; the rates vary according to circumstances.

Protection is given to private buoys by the 1st and 2nd Geo. IV. c. 75, in which it is enacted, that "if any person shall wilfully cut away, cast adrift, remove, alter, deface, sink, or destroy, or in any way injure or conceal any buoy, buoy-rope, or mark, belonging to any ship or vessel, or which may be attached to any anchor or cable belonging to any ship or vessel, whether in distress or otherwise, such person so offending shall, upon conviction, be adjudged guilty of felony, and shall be liable to be transported for any term not exceeding seven years, or to be imprisoned for any number of years, at the discretion of the court."

Buoys are either hollow, floating, water-tight bodies, formed of various substances, or they are masses of wood, reeds, &c., which are specifically lighter than water. A well-regulated system of buoys is of the utmost consideration; for on coasts where accumulations of sand and silt are continually forming and changing their positions, dangers are detected only by the vigilance of authorities, whose special duties are to watch over the navigation of shipping in the channels and entrances to our ports.

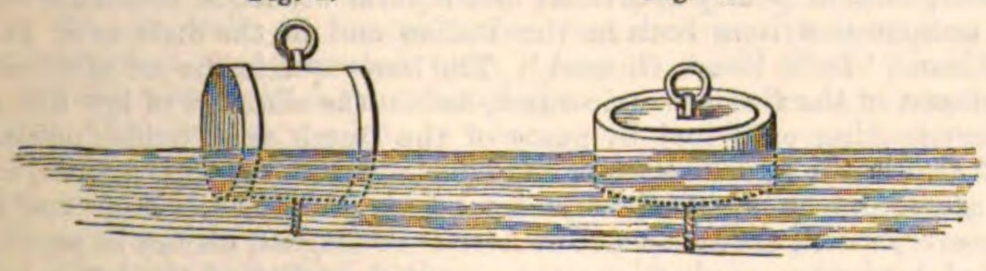
Buoys are anchored or "moored" in the neighbourhood of dangers, and usually have the name of the sand, or shoal, or spit of rocks painted on them. They are coloured red, white, black, or often chequered in these colours. Their chief use may be familiarly illustrated thus: Suppose a channel or coast to abound so much in reefs or sands that a safe passage among them could only be made by sailing in various directions (and many parts of our shores, such as the Thames, the Mersey, Spithead, &c., are beset with these difficulties); safe passages among these are so "buoyed off," that buoys of certain colours line, for example, the right-hand side of the passages, while buoys of a different colour mark the left-hand side of the passage or channel. Buoys are also attached to ships' anchors, and mark their position when these are let go. A large saving of property is thus effected, as the buoy facilitates the recovery of the anchor in cases where the cable has been broken, or when it has been cut in order to provide, on emergency, for the safety of the ship, and when time or other circumstances did not permit of the anchor being *weighed*, or lifted into the ship. Those used for shoals are generally called "Can Buoys" (*fig.* 1), and frequently have balls or beacons attached; those for ships' anchors are termed "Nun Buoys" (*fig.* 2 and 3), and are of wood or iron. Another

Fig. 1. Fig. 2. Fig. 3.



kind is used for mooring ships in harbours or sheltered roadsteads; these are generally cylindrical (*fig.* 4 and 5) and have a large iron ring

Fig. 4. Fig. 5.

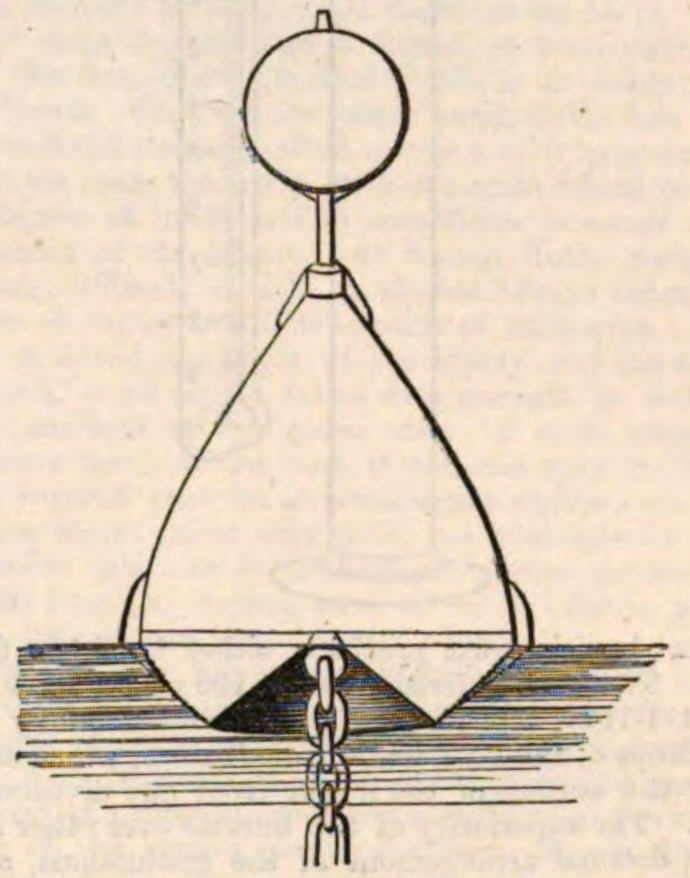


attached to the part above water. Buoys are also used to mark the position of a submerged wreck, and are usually painted green, and have the word "Wreck" in white letters. In 1853, special attention was given to the construction of buoys. The form of a floating body which should offer the least resistance to rushing water, (such floating body being confined to the ground by a chain and anchor,) and be capable of mounting the very crest of a wave, and thus be uniformly visible to

mariners, was a desideratum which only nature itself could satisfy. Like the naval architect, who in his extremity availed himself of the lines of the fish as a criterion of form for "speed," so did the mechanic and engineer look to nature for hints on true principles in mooring; and an excellent method of confining a floating body to the ground beneath was observed in several water-plants, and particularly in the lotus, and the gorgeous Victoria Regia. It was for Mr. George Herbert to perceive from these that the cable or confining apparatus should not, as before, be attached to the lowest point of the substance immersed, but should as nearly as practicable be made to hinge on to a point in the line of floatation. Mr. Herbert appears to have succeeded in the forming of iron buoys, of admirable qualifications, as proved to the satisfaction of the Trinity Board.

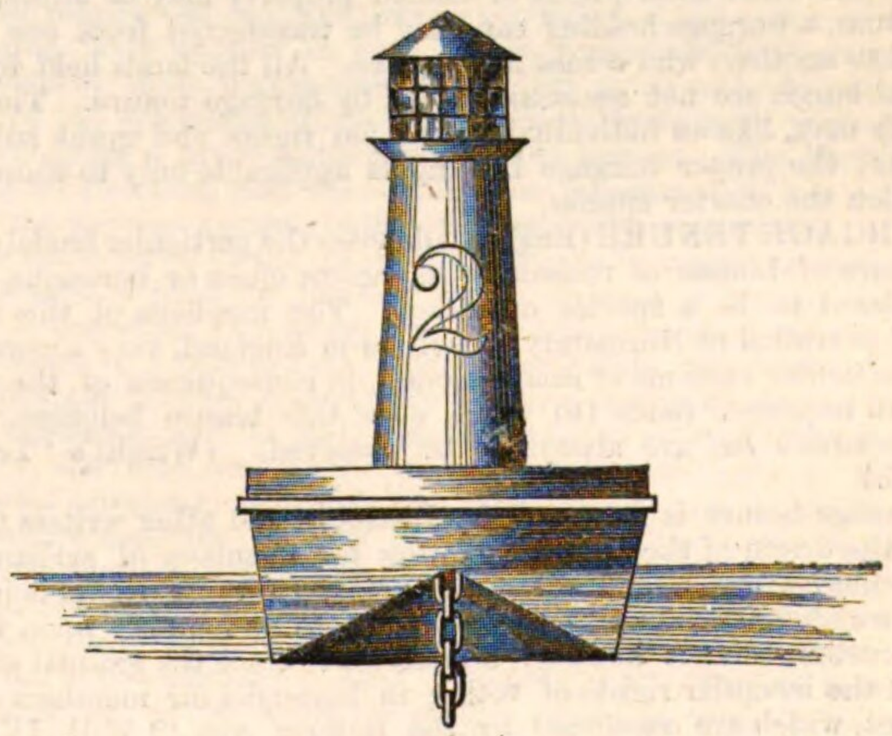
His mode of construction (*fig.* 6) gives the following advantages

Fig. 6.



namely: the tendency to pitch and roll is greatly reduced, the weight of the mooring chain is suspended from near the centre of gravity of the mass, and this, together with the resistance of the body of water filling the conical hollow of the bottom of the buoy, imparts great stability to the whole, as all leverage acting upon the centre of gravity is avoided. Thus, the body will be always borne upon the top of a wave, rather than *dragged through* it; its shape offering little resistance to the waters, and therefore the tide has very little power to force it from its floating perpendicular. They have been adopted by the Trinity-house accordingly.

From the mere buoy, Mr. Herbert was led to the consideration of floating light-vessels (Light, Floating), and safety buoys (Life Buoys). The following is a sketch of his proposed "Fairway" Lighthouse for the British Channel; but this interesting subject will be more conveniently explained under the word Collisions at Sea.

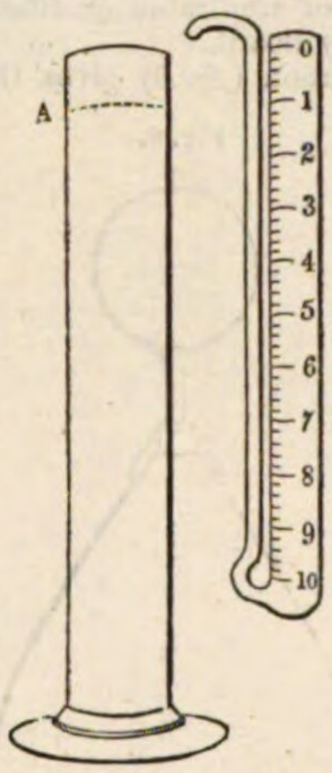


On board ship, the order to "stream the buoy and cockbill the anchor," is given when the anchor is required to be placed in such position (that is, suspended by its ring only to the cathead) as to be easily *let go* at a moment's notice; the *streaming* of the buoy meaning the throwing it into the water all clear of the ship, attached by its buoy rope to the crown of the anchor over which it is said to *watch*.

(See *Nautical Magazine;* Herbert, *On the Construction of Floating Bodies*, &c.)

BURETTE, an instrument in chemistry, invented by M. Gay-Lussac, for the purpose of dividing a given portion of any liquid into

100 or 1000 equal parts. It is accompanied by a cylindrical glass measure, containing, when filled to the line A, ½ litre; and if the fluid to be divided be less than this quantity, the deficiency must be supplied by water. In filling this measure, it is the surface of the fluid which must be made to coincide with this mark, and not the outer margin elevated by capillary attraction above the general level. The burette consists of a large tube graduated into 100 equal parts (in the figure only half the number of the small divisions are represented), and numbered from the top downward; and of a small tube connected with the former at the base, and recurved at the top. Through this tube, if the beak be slightly greased, the contents of the large tube



may be poured with great precision, either by single drops or in a full stream. The largest divisions are 1-100 of the large measure, and the smallest 1-1000, and these may be sub-divided by counting the number of drops of the fluid under examination, which are poured out in reducing the surface of the liquid from any division to the next inferior one. The superiority of the burette over other measures consists in the decimal arrangement of the graduations, and the great rapidity and precision with which any required portion of a liquid may be added or abstracted, while one hand only is employed, the other being left at liberty to use the stirring rod or test paper.

The burette, though applicable to the processes of the analytic chemist, is a very useful instrument in manufactories where the value of numerous samples of acids, alkalies, bleaching powder, &c. has to be quickly and correctly ascertained. Several modifications of this instrument are in extensive use in this country. [ALKALIMETRY.]

BURGAGE HOLDING is one of the forms of feudal tenure in Scotland. The holders of the the fiefs under the charters of privileges in favour of the burghs, held directly of the crown, returning service by watching and warding. The return is now merely nominal, but the holding is still of the crown, the investiture or sasine being given by the magistrates of the burgh. The peculiar character of this holding has preserved in modern practice the important distinction, that while other descriptions of landed property may be subfeued ad infinitum, a burgage holding can only be transferred from one crown vassal to another, who comes in his place. All the lands held by or of a royal burgh are not necessarily held by burgage tenure. The community may, like an individual, obtain feu rights and grant subinfeudations; the proper burgage holding is applicable only to those lands to which the charter applies.

BURGAGE TENURE (England) denotes the particular feudal service or tenure of houses or tenements in ancient cities or boroughs. It is considered to be a species of socage. The incidents of this tenure, which prevailed in Normandy as well as in England, vary according to the particular customs of each borough, in consequence of the maxim that, in improper feuds (to which class this tenure belongs), the *lex et consuetudo loci* are always to be observed. (Wright's 'Tenures,' p. 205.)

Burgage tenure is supposed by Littleton and other writers to have been the origin of the rights of voting for members of parliament in cities and boroughs; and the great variety of those rights is in some measure accounted for by supposing them to be founded upon varying local customs. It is however impossible to trace the gradual steps by which the irregular rights of voting in boroughs for members of parliament, which are continued by the Reform Act (2 Will. IV. c. 45) until the extinction of existing interests, were derived from burgage tenure.

BURGESS. [MUNICIPAL CORPORATIONS.]

BURGLARY. The derivation of this word is quite uncertain. By some writers it is supposed to have been introduced by the Saxons, and to be compounded of *bury*, a castle or house, and *larron* or *latro*, a thief. But Spelman conceives that the term was introduced into the criminal law of England from Normandy, and says that he finds no traces of it among the Saxons. (Spelman's 'Glossary,' tit. 'Burglaria' and 'Hamesecken.') The offence of burglary at common law is defined

to be "a breaking and entering the dwelling-house of another in the night, with intent to commit some felony within the same, whether such felonious intent be executed or not." By the statute 7 & 8 Geo. IV. c. 29, s. 11, entering the dwelling-house of another with intent to commit a felony, or being in such dwelling-house and committing a felony, or in either case breaking out of the house in the night-time, was declared to constitute a burglary, and to be punishable with death. Simple burglary is now, however, punishable by penal servitude for life, or for a term of years, or by imprisonment not exceeding three years. The capital punishment is retained where the offence is accompanied by an assault with intent to murder, or by stabbing, cutting, wounding, beating, or striking, any person in the house. (7 Will. IV. and 1 Vict. c. 86; 20 & 21 Vict. c. 3.) The leading characteristics of this offence are, 1st, that it must be committed in the night time, that is, at a time when people are presumed to be sleeping; and therefore it is said in the books, that if there be a sufficient dawning of "daylight or *crepusculum*, either begun or left, enough to see a man's face withal," when the offence is committed, it will not be burglary. The reason of the rule is that the offence, to be complete, must have been committed in the dead of night, and it follows from this reason that a burglary might be committed in the brightest moonlight. By the 7 Will. IV. and 1 Vict. c. 86, s. 4, however, night is to be considered as commencing at nine o'clock in the evening, and ending at six in the morning.

2. There must be a breaking and entering of the house; which parts of the offence however are completed by the robber even breaking a pane of glass and putting in his hand with a felonious intention.

3. The house broken must be the dwelling-house, or, as it is called, the "mansion-house" of the person injured. By this is meant that it must be a permanent dwelling, and not a booth or tent; and also that it must be the place of the actual and personal residence of man, and not a mere stable, barn, or outhouse: unless such buildings are connected with the dwelling-house. The 7 & 8 Geo. IV., c. 29, s. 13, defines what buildings within the curtilage shall be deemed part of a dwelling-house for purposes of burglary. Upon this part of the subject a great variety of nice distinctions have arisen, for which we refer to HOUSE-BREAKING.

By the 14 & 15 Vict. c. 19, being found by night armed with intent to break into any house and commit felony, or having the possession by night of housebreaking implements, or having the face blackened or otherwise disfigured, or being found by night in a house with intent to commit a felony therein, is a misdemeanour punishable by imprisonment not exceeding three years.

BURGOMASTER, BÜRGERMEISTER, is the title of the chief magistrate of a mnnicipal town, answering to the English mayor. In the German free towns the bürgermeister is the president of the executive council of the republic. This is also the case at Zürich, Basel, Schaffhausen, and some other Swiss cantons; while at Bern, Freyburg, and Luzern, the corresponding magistrate is called schultheiss (in French 'avoyer'), and in the rest of the cantons landamman; which last is a Swiss term.

BURGOS LUSTRE. A kind of gilding upon china, produced by the double sulphide of gold and potassium. The latter is prepared by heating to redness finely divided gold, with sulphur and carbonate of potash.

BURIAL. [INTERMENT.]

BURIN. [ENGRAVING.]

BURLESQUE, a word derived from the Italian adjective "burlesco," which is applied to qualify words, gestures, or expressions of the countenance intended to excite laughter. The Italian verb "burlare" means to mock or mimic, and also to laugh at a person and make him a dupe. In the latinity of the middle ages we find "burlare" used as synonymous with "ludere." (Ducange.) The burlesque style is applicable both to conversation and pantomime, and to written composition and the art of drawing. Facetious anecdotes and repartees exposing some blunder or turning something into ridicule are styled burlesque. The burlesque style however is most common in poetry, and may be defined to be a sort of good-humoured satire. There is a class of burlesque poems in every language, such as 'Hudibras' and 'Beppo,' in English; but of all modern languages the Italian abounds most in this species of composition, which is called "poesia burlesca," or "poesia giocosa," and also "poesia bernesca." [BERNI, in BIOG. DIV.] This species of poetry is divided into several branches, each cultivated by numerous writers both in the Italian and in the dialects of Italy. (Aldeano, 'Della Poesia Giocosa.') The burlesque in the art of drawing is shown in the English caricatures, and in the sketches of low life and merry-making exhibited by many of the Dutch and Flemish painters, and also in the representations of deformed and uncouth figures, such as are found among ancient and modern sculptures. Monstrosities, however, which excite a sense of horror or disgust, cannot be properly called burlesque productions, the essential quality of the latter being to excite laughter. For the same reason, satires of the invective kind reprobating gross vice, such as Juvenal's, are quite distinct from burlesque compositions.

BURLETTA (from *Burlare*, Ital., to joke, to banter, to play), a comic *operetta*, or short opera: a musical farce.

BURMESE WARE. There are certain peculiarities about Burmese ware which render it worthy of a brief notice. The cups of small size

are made of thin strips of bamboo, woven like fine basket-work. After the first coat of varnish, the interstices are filled up with a paste made of wood-oil mixed with different fine powders, such as calcined bone, or sawdust from teak-wood. After the paste has been smoothed by the hand, the cup is laid aside to harden in a cool place; when sufficiently hardened, the surface is smoothed with pumice-stone and water. The cups are afterwards varnished three or four times, and polished by rubbing. The varnish mostly used in India and Burmah, under the name of wood-oil, is obtained by incision from the *Dipterocarpus terminatus*, and a few other trees. In the Burmese ware this varnish is not laid on with a brush, but by the hand, in order to preserve a fine surface, and to enable the workman to discover and remove any particles of dirt. When first laid on, the varnish appears of a light brown colour, which is changed to a fine black by rubbing with the hand. The varnished and polished cups are kept in a cold vault for three days, to harden the varnish. Sometimes the cups are ornamented with raised figures; these are made of the same paste that is used to fill up the interstices of the basket-work. The paste is pressed into tin moulds, and afterwards transferred to the cups or bowls; when dry, it becomes as hard and solid as wood. Occasionally the cups are ornamented with engraved designs, which are afterwards filled up with different-coloured powders, mixed with wood-oil; the surface is then smoothed with wet bran, held in the hollow of the hand. The operation is repeated, to ensure the complete filling up of all the lines; and the cups are finally varnished and polished as usual.

BURNERS. [ARGAND; GAS LIGHTING; LIGHTS, ARTIFICIAL.]

BURNING. [ARSON; BRAND.]

BURNING GLASSES and MIRRORS. Any lens of the convex kind, or mirror of the concave kind, which collects a quantity of light within a very small space, will, if the light be very strong, such as that of the sun, also collect a considerable quantity of heat, which will set fire to many substances; or, if the glass have an aperture of some size, almost any substance whatsoever. This property has been long known. The last proposition of the treatise on catoptrics attributed to Euclid is, "By concave *mirrors* placed opposite to the sun, fire may be kindled;" and the reason is explained, namely, the condensation of the sun's rays. In the 'Clouds' of Aristophanes (766, &c.), Strepsiades tells Socrates that he has found out an excellent way of cancelling his debts, namely, by standing at a distance from the lawyer who is drawing up the case against him, and destroying the writing by catching the sun's rays in such a burning-glass or transparent stone as people kindle fire with. We may see under ARCHIMEDES [BIOG. DIV.] that the stories relative to his burning the Roman fleet by mirrors are of comparatively modern authority. From the end of the 17th century various experiments have been made with glasses of considerable power; but as no important results followed, beyond the establishment of the great effect which may thus be produced, the subject has become of little importance, especially, as when high temperatures are required, the oxy-hydrogen blowpipe, or the voltaic battery is at the command of the chemist. We shall, however (referring the reader to LENS and MIRROR for all stricter notions upon the subject), state some facts connected with burning glasses in a more popular shape.

It is found that heat alone without light passes very slowly through glass; that even with ordinary light very little heat is transmitted through glass; and that it is only with the full glare of sun-light that any sensible effect can be produced. If a convex lens be held directly opposite to the sun, and allowed to throw an image on a sheet of paper held behind and parallel to it, and if the sheet of paper be moved until the image of the sun thrown upon it appear smallest, the quantity of light transmitted through the glass, which remains the same throughout, is then thrown upon the smallest quantity of surface, and presents the greatest condensation of light and heat which the glass will afford. The same phenomenon would be perceived in a concave mirror, with this defect, that the surface which is held before it must intercept a part of the light.

Two glasses were made by Tschirnhausen, before 1699, which are among the earliest of the attempts to produce considerable effects; the first of 33 inches diameter and 7 feet focal length, the second of the same diameter and 12 feet focal length (old Parisian measure). A second lens received the rays and diminished the focal distance. The effect was to burn small portions of wood, or boil water, also in small quantities, in one moment; to melt small pieces of metal, to vitrefy slate, &c.; to melt pitch and resins under water. But the most complete effect was produced from a lens made by M. de Trudaine, about 1774, which did not consist of glass alone, but was a hollow lens of glass, filled first with spirits of wine, which was afterwards changed for terebinthine oil. It held 140 pints (Parisian), and filled with the latter substance had about eleven feet of focal length. According to M. Brisson (afterwards cited), who made the experiments, a bar of steel, four inches long and a third of an inch square (Parisian), was completely melted in five minutes. A silver coin of three livres was melted in a few seconds, and one of six livres in nearly the same time; grains of platinum were sufficiently melted to cohere, though not to form a spherical drop.

M. Buffon, remembering the story about Archimedes, endeavoured to form mirrors which should burn at a great distance. The disadvantage of trying to gain power by increasing the aperture lies in the great relative increase which is thereby given to the small image of the sun. No *spherical* glass or mirror refracts or reflects rays accurately to a point. The plan of M. Buffon was to make his mirror consist of a large number of small plane mirrors, 400 in number, so placed that they should all reflect their several images of the sun on the same point. He thus burnt wood at 200 (French) feet distance, melted tin at 150 feet, and lead at 140 feet.

The only practical application of the burning glass (if it deserves so dignified a name) of which we ever heard, is the following: A burning glass is placed in such a way that the sun shall throw its image into the touch-hole of a small cannon, at its greatest height, which thus explodes within a minute or two of noon, if there should happen to be no cloud in the way.

BURNS AND SCALDS. Burns are produced by heated solids; scalds by heated fluids. The severity of the injury is dependent mainly on the intensity of the heat of the burning body. Fluids are not capable of acquiring so high a degree of temperature as some solids; hence the immediate effect of scalds is generally less violent than that of burns. But, on the other hand, fluids flow about with great facility, and the accident often causes a very large surface of the fluid to be thrown upon the body, so that a scald which produces only a moderate degree of inflammation sometimes becomes exceedingly severe on account of its extent. As heated fluids part with their caloric in being diffused, a scald is almost always attended with a different degree of injury in different parts of its course. The extent of the surface involved, the depth of the injury, and the sensibility of the part affected, must all be taken into account in estimating the danger of the accident in any given case. A burn which produces the instantaneous death of the part it touches may be free from all danger if the injured part be circumscribed within a small compass. The worst burns which occur arise from the explosion of gunpowder, or of inflammable gases, or from the female dress catching fire; and the worst scalds from the boiling over of heated fluids in breweries, manufactories, laboratories, &c.

The immediate seat of the injury produced by burns and scalds is the skin, which is a highly organised membrane, performing a very important organic function, and endowed with a high degree of sensibility. [SKIN, NAT. HIST. DIV.] The organic function performed by it is the secretion of a quantity of aqueous fluid from the blood, which is carried out of the system under the form of perspiration. The secretory arteries of the skin are excited to such an unusual degree of action by the stimulus of the heated body, that they pour out an aqueous fluid in such quantity as to lift the cuticle from the cutis or true skin, and form a vesicle or bladder full of fluid. Such is the violence done to the true skin, that the function of all the injured portion of it is suspended; additional labour must therefore be imposed on some other organ, which must be its substitute and perform its work, otherwise a fatal disturbance will take place in the system. The lung exhales the same aqueous fluid as the skin. [LUNGS, NAT. HIST. DIV.] In proportion as the cutaneous perspiration is diminished, the pulmonary transpiration is increased; but when a large extent of the skin is destroyed, the lung is inadequate to the task imposed upon it; it cannot perform its own work and that of the skin also, and in this case great difficulty of breathing invariably comes on, and the danger is exceedingly increased by this oppression of the lung.

But there is spread over the external surface of the true skin an immense number of sentient nerves, rendering it an organ of sense. A burning body applied in such direct contact with the sensitive extremities of these nerves occasions violent pain; and this, in consequence of the sympathy which is established between all parts of the body, produces a great disturbance of the system. The abolition of the organic function, and the disturbance occasioned to the sentient part of the nervous system, both combined, often prove fatal.

Since the severity of the injury must always be mainly in proportion to the length of time the burning body continues in contact with the skin, it is important that every one should impress upon his mind the course which it is best to take in case of accidents from burns.

The upright posture is obviously not only favourable to the spreading of the flames, but to their reaching the more important parts of the body, the neck and head. Any motion of the body to and fro gives great advantage to the flames, by bringing fresh currents of air into contact with the burning materials, and it is therefore utterly absurd to run screaming about. Fall upon the floor; keep rolling over and over upon the carpet: if possible seize the hearth-rug, or the table-cover, and, enveloping the body in it, keep rolling about upon the carpet until assistance comes. The duty of the assistant is to seize the hearth-rug, or the table-cover, or a shawl, or to strip himself of his coat, or to seize any woollen or flannel clothing at hand and to envelope in it as closely and completely as possible the person on fire.

The thing to be done with the burnt or scalded parts is instantly to immerse them in cold water, ice-cold if it can be got. Should the position of the parts not allow of their immersion in water, cloths should be applied to them dipped in water, and kept constantly wet. As a means of applying and retaining cold, scraped potatoes or turnips are useful. Some persons recommend, instead of those cooling applications, stimulating substances, such as the strongest brandy, spirits of wine, oil of turpentine, or vinegar, kept on the affected parts, by means of old linen or lint soaked in the fluid. The use of these applications,

whether the cooling or the stimulating, should be persisted in until the pain ceases; the parts should then be dressed, as some recommend, with the yellow basilicon ointment, softened with the oil of turpentine; or, as others prefer, with emollient poultices often renewed. It is singular that, common as this piece of surgery is, practitioners are not agreed which of these two plans, the cooling or the stimulating, is the most efficient; and comparative trials have not yet been made on a scale of sufficient extent to determine the question. It is probable that the one may be more advantageous than the other under different circumstances, which the unprofessional person cannot be expected to discriminate. All that is necessary to be stated here is the most judicious thing to be done, in the very first instance, until professional assistance can be procured; and with this view, perhaps, the only thing that should determine the choice between either of the cooling or stimulating articles just mentioned is the facility with which they can be got. It is probable that the chief effect of all these applications is to prevent the air from coming into contact with the true skin; that is, to perform the office of the cuticle which is destroyed. Accordingly, some of the most distinguished surgeons state that they have produced the very best effects by merely covering the affected parts with old linen saturated with oil, by which the air is effectually excluded. On the same principle the part may be enveloped in cotton, or powdered over with flour.

BURNT ALUM. [ALUM.]

BURNT-EAR. *Burnt-ear*, in corn, is a disease in which the fructification of the plant is destroyed and, as it were, *burnt* up; hence its English name, and the corresponding terms of *charbon* in French and *brand* in German. Burnt-ear has often been confounded with *smut*, which is a similar but distinct disease. They differ in this, that in the *burnt-ear* the black powder which appears in the ear is external, and the grain has either never been formed, or its coat has been destroyed, so that the whole ear appears black or burnt. The powder also has no smell, and, being easily blown away by the wind, or shaken off in the reaping, little of it adheres to the corn or is mixed with it when ground; and except the loss of so much grain as would have been contained in the sound ears, no great detriment arises to the quality of the corn. The smut, or pepper-brand, on the contrary, is contained in the body of the grain, which retains nearly its natural form, and is carried along with it into the barn. It is only in the threshing or grinding that the diseased grain commonly called smut-ball is broken, when a fetid black powder is dispersed over the sound grain, which greatly deteriorates the flour, and renders the corn unfit for seed, the disease being perpetuated by this black substance. [SMUT.] Burnt-ears are generally observed in particular moist situations, and some lands are more subject to them than others. The disease has been often attributed to damp and warm fogs succeeding very dry weather: and hence it has been imagined that it was caused by the dews lodging in the ears and producing a species of rottenness. But microscopic observations have decidedly proved that the black powder consists of the minute germs or seeds of a parasitical fungus, which are developed in the growing ears and live on its substance.

The plants attacked by this disease may be distinguished long before the ear makes its appearance out of the sheath in which it is enveloped in its early state. There is a peculiar greenness of the leaf observable; and when the plant is examined, the young ear may already be seen attacked by the disease and beginning to put on a spotted and black appearance, which increases as it grows, and is perfected when the ear arrives at the state in which the flower should appear. In some cases the plant flowers partially or completely, and the fecundation takes place, so that the germ is developed; but it never approaches to maturity. Its outer skin is soon destroyed by the parasitical fungus, and the whole substance converted into a black powder.

De Candolle, one of the best modern authorities on the physiology of plants, has named this peculiar minute fungus the *Uredo carbo*, which he distinguishes from that which produces the smut, and which he calls *Uredo caries*. They are easily distinguished by the size and smell. The *Uredo carbo* (*Uredo segetum*) is composed of much smaller globules, and destitute of smell; both seem to be propagated like other cryptogamous plants by means of extremely minute germs, which are carried along with the sap into the circulation and vegetate in the ear, where alone it appears that they find the conditions necessary to their growth.

It is doubted by some whether the disease is contagious, because they have never been able to produce it by shaking the black dust of burnt-ears over the sound plants. The reason of this is probably that the exhaling vessels of the surface are not so well calculated to absorb extraneous matter, which can only enter by the spongioles of the roots. Although it is much less dangerous than the smut, because it is readily dispersed by the winds, yet it must more or less infect the soil, and hence the disease is more frequent where it has appeared before, and where those grains which are most subject to the disease, such as wheat, barley, and oats, have been sown in too rapid succession. As it does not adhere to the grain, steeping and washing are not so certain remedies against the infection as in the case of smut; but the best preservative is to drain the land well and keep it in good heart, so that the plants may be vigorous and able to resist the attacks of the parasite; for it is a well-known fact, that weak plants, as well as animals are much more exposed to the attacks of parasitical plants or animals than those which are vigorous and robust. A judicious change of crops, or a well-established rotation, will in general secure the corn, which is sown in its proper course, from the infection of the *Uredo carbo*, provided the preparation of the land be such as to ensure a healthy vegetation.*

As this disease is extremely common, it has obtained various names in different parts of the country. In England it is best known by the names of blacks, brand, or burnt-ear; and it is often called *smut*, from the supposition that it is a variety of the same disease which attacks the external part of the fructification before the skin of the grain is formed.

BUSHEL. This word seems to be a diminution of an old English word *buss*, signifying a box or vessel, and still used for small fishing-boats. Fleta describes the bushel as containing eight pounds (libræ) of corn, and eight bushels as making a quarter (quarterium); Spelman, as containing four gallons (galones) of wine. Dr. Bernard asserts the bushel to be 72 pounds troy of common corn (triticum), or 59·1667 avoirdupois. By the act of 1697 the Winchester round bushel was to be 18½ inches in internal diameter and 8 inches deep, or 2150·42 cubic inches. The standard of length implied was the old exchequer standard. By the Act of 1824 the standard gallon contains 10 pounds avoirdupois of pure water; eight such gallons make a bushel, and eight bushels a quarter. This, by the other provisions of the Act, made it contain 2218·2 cubic inches very nearly. The content of the bushel seems to have been gradually increasing. Arbuthnot (1727) makes it 2178 cubic inches; Eisenschmidt (1737) 2180·4 cubic inches. The bushel is now 36·347 French *litres*. The *heaped* bushel, for goods which were heaped above the measuring vessel, such as coals, fruit, &c., and which was estimated at 2815·5 cubic inches, was abolished by 4 & 5 Will. IV. cap. 49, an Act which took effect from the 1st of January, 1835. The relation which the "imperial" bushel, as it is now called, bears to other measures of capacity, and to certain weights, will be found noticed in a later article. [WEIGHTS AND MEASURES.]

BUSKIN, a covering for the foot, coming some distance up the leg, fit for a defence against dirt, thorns, &c. This word is also used in English as the translation of the Greek and Latin word *cothurnus*, which signifies a sandal with a high cork sole used by the Greek and Roman tragic actors to give an appearance of elevation to their stature, in conjunction with the mask and other stage properties. The cothurnus was also used by persons of high station in hunting, &c., and was often richly ornamented. The cothurnus was worn by ladies to add height to their stature. In Greek art, Diana is usually represented with the cothurnus. The colours of the buskins were varied; purple for Dionysus, white for ladies, and red for warriors. *Cothurnus* in Latin is employed in contradistinction to *soccus*, the flat-soled shoe worn by slaves and comedians. Hence, in English authors the words *buskin* and *sock* are often used for the tragic and comic drama. So Dryden,

> "Great Fletcher never treads in buskins here,
> Nor greater Jonson dares in socks appear."

BUST, in Sculpture, means a statue truncated below the breast. The etymology of the word is not very clear. The Romans called 'bustum' the place where they burnt the bodies of the dead, from 'bustum,' burnt. Bustum was afterwards used for the grave in which the body was buried; and lastly, in the latinity of the lower ages, for the dead body itself: 'Sanctorum busta,' the bodies of martyrs (Ducange). Bustum seems to have been used more especially for the trunk of the body without the head: "Quinque hominum busta sine capite cæsa." ('Annal. Mediolan.' in Muratori.) In the old French, 'bu' meant the trunk: "Car ils ont bien armé le chef et le bu." (Old French Romance, Ducange.) 'Busto,' in Spanish and Italian, has a similar meaning. The Italians call also 'busto' the stays which embrace and support the breast. In Sculpture, however, bust includes the head, shoulders, and breast, with the arms truncated above the elbow, and as such, it forms a large department of the art. Busts were mostly used by the ancients to represent likenesses of individuals, and were placed either upon sepulchral monuments, or in the interior of houses, or in gardens. The Greek word *Hermæ* has been sometimes considered as synonymous with the modern bust, but the Hermæ were merely heads placed on a quadrangular pillar. Portrait busts are of all kinds of sculpture what most employ the chisel of the modern sculptor, especially in this country; and this is consequently a branch of the art in which English sculptors excel. Chantrey especially was famous for his skill in this line; probably as much surpassing most contemporary European sculptors in the execution of portrait busts as he was inferior to several of the more eminent in the higher branches of statuary.

BUTIC ACID ($C_{40}H_{40}O_4$). One of the acids contained in cows' butter. It is distinguished from stearic acid by being less soluble in alcohol, and by being more easily precipitated by acetate of magnesia.

BUTTER. Butter is the fat or oleaginous part of the milk of various animals, principally of the domestic cow. The milk of the cow is composed of three distinct ingredients, the curd, the whey, and the butter;

* Steeping the seed in brine or stale urine, and drying it with fresh-slaked lime, as is usually done with wheat, is however a useful precaution, which should be adopted also with barley and oats, wherever burnt-ears have appeared in preceding crops. A solution of sulphate of copper is also generally used, and is certainly more efficacious than common salt.

the two first form the largest portion, and the last the most valuable. The comparative value of the milk of different cows, or of the same cows fed on different pastures, is estimated chiefly by the quantity of butter contained in it; and in this respect, some breeds of cows are far superior to others. The union of the component parts of milk is chiefly mechanical, as they separate by subsidence according to their specific gravities, the cream being the lightest, and the curd the heaviest; the curd, however, requires a slight chemical change for its separation from the whey, which at the same time produces a peculiar acid, called the lactic acid. From the moment that milk is drawn from the cow it begins to be affected by the air and changes of temperature, and circumstances almost imperceptible to our senses will materially affect its quality. [MILK.] Hence the importance of extreme care and attention in every step of the process of the dairy, especially in making butter.

The cows should be milked in the cool of the morning and evening; they should not be much driven or heated immediately before milking; and it is best to bring them to the place of milking some time before the operation begins. In some situations it is better to milk them in the pastures, and carry the milk home; in others, to drive the cows gently to the cow-stall. In mountainous countries the first mode is generally adopted, because the cows are apt to leap down steep places, and shake the milk in their udders more than is done by carrying it in the pail. The same practice holds good in Holland; on account of the great distance of the pastures from the home-stall, and on account also of the facility of transporting the milk in small boats, all the best pastures being surrounded by small canals communicating with the greater; so that the milk may be carried several miles without the least agitation. In England, where the pastures frequently surround the habitation of the dairyman, the cows are generally driven home twice a day to be milked. As the slightest acidity or putrescence immediately causes an internal chemical action in milk, it is of the greatest importance that the place where the cows are milked, and the persons employed, should be of the greatest purity and cleanliness. The milking-house should be paved with stone or brick, and no litter or dung be permitted to remain in it. It should be washed out twice a day, immediately before each milking; which, besides ensuring cleanliness, produces a refreshing coolness highly useful to the milk. The teats of the cows should be washed clean with water and a sponge. The vessels in which the milk is drawn from the cow should also be kept scrupulously clean.

The milk, as soon as it is brought into the dairy, is strained through a fine sieve or cloth, in order to remove any extraneous matter; and it is then poured into shallow pans, or troughs lined with lead. The best pans are of metal; either of iron carefully tinned, or of brass. Such pans are cool in summer, and in winter allow of the application of heat, which is often very useful to make the cream rise. When leaden troughs are used, they are generally fixed to the wall, and have a slight inclination towards one end, where there is a hole with a plug in it; by drawing this plug, the thin milk is allowed to run off slowly, leaving the cream behind, which runs last through the hole into the pan placed under to receive it. Glass pans and pans made of earthenware are now largely used, and have the advantage of being more easily kept clean than any others. The milk in the pans or troughs is generally four or five inches in depth, a quantity found most conducive to the separation of the cream. The place where the milk is set should have a thorough draught of air by means of opposite wire windows. The sun should be carefully excluded by high buildings or trees; and the floor, which should always be of brick or stone, should be continually kept moist in summer, that the evaporation may produce an equal cool temperature. A small stove in winter is a great advantage, provided smoke or smell be most carefully avoided, and the temperature be carefully regulated by a thermometer. All these minutiæ may appear superfluous to those who have no practical knowledge of the dairy; but good butter cannot be ensured without them. It is well known that even the complexion and temperament of a dairy-woman are not a matter of indifference; and that however clean she may be, there are times when the insensible perspiration of her body will have a powerful effect on the milk. In Switzerland men are chiefly employed to milk the cows, and in all the processes of the preparation of butter and cheese. The women only clean the utensils, and carry green food to the cows when they are kept in the stable. When the milk has stood twelve hours, the finest parts of the cream have risen to the surface; and if they are then taken off by a skimming dish, and immediately churned, a very delicate butter is obtained; but in general the milk is left twenty-four hours, when the cream is collected by skimming, or the thin milk is let off by taking out the plug in the troughs. All the cream is put into a deep earthen jar, which should be glazed, but not with lead; stone ware is the best. More cream is added every day till there is a sufficient quantity to churn, which in moderate dairies is every two days. It is usual to stir the cream often, to encourage a slight acidity, by which the process of churning is accelerated. This acidity is sometimes produced by the addition of vinegar or lemon-juice; but however this may facilitate the conversion of the cream into butter, we would not recommend it, as the quality is decidedly injured by it, especially of butter which is to be salted. The change by which the butter is separated in a solid form is accompanied by the development of heat in churning. That the state of the atmosphere

with respect to electricity as well as the temperature has a powerful influence on the making of butter, no one can doubt who has paid any attention to the effect of a thunderstorm in a dairy, especially when it occurs at the time of churning. The day may arrive when an electrometer will be found as useful in a dairy as a thermometer is already.

The common method employed to separate the butter from the thinner portion of the cream is by strong agitation. In small quantities this may be done in a bottle, but the common instrument is the *churn*, the chief varieties of which are noticed in a separate article. In the course of an hour's churning, more or less, according to circumstances, small kernels of butter appear; these are soon united by the pressure of the board against the bottom of the churn, and form a mass of solid butter. In these churns the cream is made to revolve with the cask which holds it, and so to fall from side to side and be shaken and broken by this treatment, as it is shaken by revolving beaters in the fixed cask or box in which it is placed. The butter, when separated, is collected with the hand, and placed in a shallow tub for the next operation. The butter-milk is set aside as a drink for pigs, or for domestic use. The butter is still mixed with some portion of butter-milk, but much of its quality for keeping depends on their perfect separation. The most usual way is to spread it thin in a shallow tub, beating it with the hand or a flat wooden spoon, and washing it repeatedly with clear spring water, until all milkiness disappears in the water which is poured off. Some experienced dairymen assert that the butter is deteriorated by much washing, and therefore express the butter-milk by simply beating the butter with the hand, kept cool by frequently dipping it in cold water, or with a moist cloth wrapped in the form of a ball, which soaks up all the butter-milk, and leaves the butter quite dry. This operation requires the greatest attention, especially in warm weather, and no person should work the butter who has not a very cool hand; the less it is handled the better, and therefore a wooden spoon or spatula is much to be preferred.

When it is entirely freed from the butter-milk and of a proper consistency, the butter is divided into portions of the weight required, if it is intended to be sold fresh. The mode of preparing fresh butter for the market is either by making it into *rolls* of two pounds, or into flat round cakes of one pound or half a pound each, which are impressed with some figure cut in a round piece of wood like a large seal, hence called *prints*. The rolls are made oblong with four sides slightly flattened by throwing the lump on a stone or board successively on each of the four sides, and then on the two ends; this requires some dexterity, which is soon acquired, and it is done to avoid unnecessary handling.

To make prints, the butter is first made into balls, and then applied by pressure to the wood, which gives the impressions; the sides are trimmed up along the edge of the wood, and the whole is pressed against a marble or wooden slab, so as to have the impression uppermost, and form a flat cake. The wooden print is readily detached by holding it in the left hand, and giving a smart blow with the right. A hole bored through the centre prevents the adhesion of the butter from the exclusion of the air. In Cambridgeshire butter is made up into rolls a yard long, and passed through a ring of a certain diameter, for the convenience of dividing it into small portions without the trouble of weighing: hence the butter is said to be sold by the yard.

The greatest portion of the butter that is made, especially at a distance from large towns, is immediately salted and put into casks or firkins, which usually contain fifty-six pounds. The quality of the salt used is of great importance; if it be pure, the butter will keep its flavour for a long time, but when it is impure and contains bitter and deliquescent salts, the butter soon becomes rancid. The Dutch are very particular on this point. They use a kind of salt which is made by slow evaporation, and perfectly crystallised; the salt is intimately mixed with the butter. From three to five pounds are sufficient for a firkin of fifty-six pounds. Some dairymen recommend the use of a substitute for plain salt, consisting (for every pound of butter) of half an ounce of dry pounded salt, two drachms of sugar, and two drachms of saltpetre. The casks are made of clean white wood; they are carefully washed inside with strong brine made hot, and rubbed over with salt. The butter being quite dry is pressed close into the cask, a small layer of salt having been first put on the bottom. Every addition is carefully incorporated with the preceding portion. If there is not a sufficient quantity to fill the cask at once, the surface is made smooth, some salt is put over it, and a cloth is pressed close upon it to exclude the air. When the remainder is added, at the next churning, the cloth is taken off, and the salt which had been put on the surface carefully removed with a spoon. The surface is dug into with a small wooden spade, and laid rough, and the newly salted butter is added and incorporated completely. This prevents a streak which would otherwise appear at the place where the two portions join. When the cask is full some salt is put over it, and the head is put in. If the butter has been well freed from all the butter-milk, and the salt mixed with it quite dry, it will not shrink in the cask, and it will keep its flavour for a long time. Should there be an appearance of shrinking, the cask must be opened, and melted butter poured round it so as to fill up the interstices between the butter and the cask; in this way it will not suffer in

its quality. There is a mode of preserving butter for domestic use without salt, in the following manner:—the butter is set in a clean pan over the fire, and melted very gently; it is not allowed to boil, but is heated very nearly to the boiling point. Experience has shown this heat to be attained when the reflection of the white of the eye is distinctly seen on the surface of the butter on looking down into the pan. All the watery particles are then evaporated, and the curd, of which a portion always remains in the butter, and which is one cause of its becoming rancid, falls to the bottom. The clear butter is poured into an earthen vessel and covered over with paper; and a bladder or a piece of leather is tied over the jar to exclude the air. When it is cooled it much resembles hog's lard. It has lost some of its flavour, but it is much superior to salt butter for culinary purposes, and especially for pastry.

The Devonshire method of making butter differs materially from the common process which we have described, and is peculiar to that county. The milk, instead of being set for the cream to rise, is placed in tin or earthen pans, holding about eleven or twelve quarts each. Twelve hours after milking, these pans are placed on a broad iron plate heated by a small furnace. The milk is not allowed to boil, but a thick scum rises to the surface. As soon as small bubbles begin to appear, where a portion of this is removed with a spoon, the milk is taken off and allowed to cool. The thick part is taken off the surface, and this is called *clouted* or clotted *cream*. It is a sweet, pleasant substance, more solid than cream, but not so solid as butter; and is considered as a dainty by all those who have been early accustomed to it. A very slight agitation converts it into real butter; after which it is treated exactly as we have before described. It does not appear that there is any peculiar advantage in the Devonshire method.

Another method of making butter, which is more generally adopted, is to churn the milk and cream together. This method is pursued in parts of Holland, Scotland, and Ireland, and is said to produce a greater abundance of butter from the same quantity of milk. In the Dutch method the milk is put into deep jars in a cool place; each *meal*, or portion milked at one time, being kept separate. As soon as there is a slight appearance of acidity, the whole is churned in an upright churn, which, from the quantity of milk, is of very large dimensions. The plunger is therefore worked by machinery moved by a horse or sometimes by a dog walking in a wheel, which he turns by his weight. When the butter begins to form into small kernels, the contents of the churn are emptied on a sieve, which lets the butter-milk pass through. The butter is then formed into a mass, as described before. In Ireland the process is very similar, but the milk is allowed to arrive at a greater degree of acidity, which is a defect. In Scotland the following method is pursued: the milk is allowed to cool for six hours, and then put into a clean vat. As long as it remains sweet more milk may be added, but not after any acidity is produced. It is then covered and allowed to get sour, till it coagulates at the top; this coagulum is called the *lapper*, which must not be broken till the butter is churned. When the clotted milk is put into the churn, warm water is added, so as to raise the temperature to 70° or 80°, the whole being gradually stirred in. When this is properly conducted, the butter-milk will be very pleasant and wholesome, with a sub-acid taste, the serum and curd not being separated from each other for some time after. The butter is said to be fully equal to that made from cream alone.

Butter is a most valuable article of commerce, and a great source of wealth to those nations which produce it in the greatest perfection. The Dutch has a high character; but the rich pastures in England and Ireland can produce as good butter as those of Holland, if sufficient attention be paid to the minutiæ of the dairy, to the purity of the salt used, and especially to cleanliness, for which the Dutch are so remarkable. The quality of the butter depends on some very minute circumstances, which escape the notice of all superficial observers. The smallest particle of putrescent matter, accidentally added, and even mere effluvia, give a turn to the chemical action going on from the moment the milk is exposed to the air, and they taint the cream more or less. The quantity of pure cream which rises when the milk is set in the pans, as well as its quality, is influenced by these circumstances. When the milk curdles before the cream is separated, it is almost impossible to prevent some portion of the curd from being mixed with the butter. In its perfectly fresh state the taste is not affected by this; but the butter will not keep fresh above twenty-four hours, and when salted soon becomes rancid. Thus a greater quantity is produced, but of inferior quality. When cheese is made of the milk from which the cream has been taken, it will be found most profitable not to attempt to take off all the cream by repeated skimming; for more will be gained in the better quality of the cheese than by an increase in the quantity of the butter at the expense of the quality.

It is an acknowledged fact, that such are the niceties of the dairy, that great experience alone can ensure a produce of superior quality: this experience would be more readily acquired if the circumstances were accurately observed and noted. We would recommend to those who have extensive dairies, to mark by the thermometer the temperature of the milk and cream in the different stages of the process, occasionally to test the acidity of the butter-milk by means of alkalies, and to note any peculiarity in the atmosphere by an electrometer. A few observations carefully noted, repeated, and compared, would

throw more light on the true causes which favour or oppose the production of good butter, than all the guesses that have hitherto been made.

The quality of the butter depends materially on the nature of the pasture. The best is made from cows fed in rich natural meadows. Certain plants which grow in poor and marshy soils give a disagreeable taste to the butter. When cows are fed with cut grass in the stable the butter is inferior, except in the case of some artificial grasses, such as lucerne. Turnips and other roots given to cows in winter communicate more or less of a bad taste to butter, which is corrected in some degree by means of a small quantity of water and saltpetre added to the milk; and also, it is said, by giving salt to the cows with their food. But there is no butter made in winter equal to that which is made where the cows are fed entirely with good meadow hay, especially of the second crop, called aftermath hay, which contains few seed-stalks. Among the methods recommended for removing a taste, whether of turnips or any other plant, in the food of cows, from their butter, there may be enumerated the use of—(1) Chloride of lime (a drachm to every expected pound of butter, added to the water of the second washing); (2) Saltpetre (a dessert spoonful of a strong solution, added to every two gallons of milk as it comes from the cow); (3) Vinegar (a half-pint added to every gallon of the cream before churning); (4) Hot water (a half pint boiling added to every gallon of milk as it comes from the cow, and allowed to stand for half an hour before setting for cream). This, with cleanliness and care to avoid the use of tainted food, seems to be the most probable of success: the explanation being, that the aroma flies off with the steam, when the milk is thus kept warm for a sufficient length of time.

The yellow colour of fine May butter is frequently imitated artificially by mixing some ground arnotta root, or the juice of carrots, with the cream. This is easily detected by the taste of the butter, which is not improved by it, and has not the peculiar flavour of fine grass butter; but in other respects it is a harmless addition. Some cows give a much yellower cream than others, especially the Alderney cows, and the butter made from it is of a peculiarly fine flavour. When a cow has lately calved the milk is also much yellower, but this soon goes off if it be not the natural colour; and the butter made by mixing this with other milk, although of a deeper colour, is not improved by it.

According to the accounts of the produce of butter from different countries and various breeds of cows, it appears probable that, on an average, 4 gallons of milk produce 16 ounces of butter; and to make the feeding of cows for the dairy a profitable employment in England, a good cow should produce 7 lb. or 8 lb. of butter per week in summer, and so much less than that quantity in winter, as that, allowing from six weeks to two months for her being dry before calving, the whole produce of the year may be from 220 lb. to 240 lb. If she produces more she may be considered as a superior cow; if much less, she is below the average. To produce this quantity the pasture must be good, and if we allow three acres to keep a cow in grass and hay for a year, which is not very far from the mark, the butter will produce about 12*l.*, at the distance of 50 miles from London, if it is sold in a fresh state. This, with the value of her calf, does not much more than pay rent and expenses; but the profit is increased by feeding pigs, or making skim-milk cheese.

An inferior kind of butter is made in some cheese dairies from the oily portion of the milk skimmed from the whey, which is set in pans like milk after the cheese has been made. It is sold at an inferior price to labourers, and seldom comes to market. It is totally unfit for salting and keeping. It is known by the name of *whey butter*.

It has been discovered, within the last four years, that cheap butter is occasionally adulterated with *flint*. Flints are ground, and chemically treated until soluble, producing 'soluble silica.' When this preparation is dissolved in water, it becomes a stiff gelatinous body, somewhat resembling strong jelly. This jelly is mixed with butter of low quality, to which fresh salt and colouring matter are added. The compound bears a considerable resemblance to dairy-made butter; but it has not the firmness or bright appearance of the genuine commodity, and is devoid of the richness and wholesome qualities. Of course the object in view is to increase the weight of ordinary butter by the addition of a substance of very small cost. Unfortunately, butter consumers have seldom the skill or facilities for detecting such adulterations.

Considered in its commercial relation, butter is an article of much importance. In Europe, the greatest trade in butter belongs to the more northern nations. The quality of that produced in England and in Holland is the best in the world. A considerable quantity of Dutch butter is exported from Holland; but all the produce of England is consumed at home, in addition to large quantities imported from Ireland and the north of Europe. About the year 1790, the total quantity imported was 200,000 cwts. annually; 215,000 cwts. in 1800; 300,000 in 1810; 365,000 in 1820; 420,000 in 1825. No account of the importations from Ireland can be had later than 1825; the intercourse between the two islands having at that date been placed upon the footing of a coasting-trade. On the other hand, there is no statement of imports of butter from foreign countries of an earlier date than 1801. Therefore, it is only between 1801 and 1825 that the official tables show the real quantity of butter brought into Great Britain. It

was not possible, until recently, to state the quantity of butter exported from the United Kingdom to our colonies and foreign countries, in consequence of the practice at the Custom House of including butter and cheese in the same statement; but this deficiency has been now amended. The shipments of butter so made are entirely of the produce of Ireland; the chief customer is Portugal, and next to that is Brazil.

Understanding, then, that the amount of butter brought from Ireland for consumption in Great Britain cannot now be officially ascertained, we may conclude that all estimates on the subject are merely approximate. Mr. M'Culloch, some years ago, estimated the London consumption of butter at about 15,000 tons annually; but we do not know on what data this estimate was made. The Irish butter-trade at Cork is conducted in a remarkable way. There is a committee of members, consisting of buyers, sellers, and factors, to superintend all the dealings. All the butter brought to market is inspected and branded by order of the committee, and is divided into four kinds, according to quality. A sub-committee each morning fixes the price at which each kind of butter shall be sold on that day; the four kinds differ in value about 5*s.* per cwt. from each other. The butter-buyers are in the habit of advancing money beforehand to the dairy-farmers; insomuch that sometimes a whole season's produce is paid for before any of the butter is made. In average years, about half a million firkins of butter are branded at Cork.

The Board of Trade tables in recent years have presented the following figures relating to the import of butter;—

1856	513,392	cwts.
1857	441,606	„
1858	390,040	„

And the following relating to exports (wholly Irish) :—

1856	139,548	cwts.
1857	110,974	„
1858	112,308	„

Various Acts of Parliament were passed in bygone years, with the view of preventing fraudulent practices in the packing of butter; but this kind of legislative interference is now abandoned. At various times during the present century the duty on imported foreign butter varied from 2*s.* 9*d.* to 21*s.* per cwt. The price paid for butter at Greenwich Hospital for about a century past has varied between the limits of 5*d.* and 14*d.* per pound.

BUTTER OF ANTIMONY. [ANTIMONY, TERCHLORIDE OF.]

BUTTER OF TIN. [TIN, BICHLORIDE OF.]

BUTTER OF ZINC. [ZINC, CHLORIDE OF.]

BUTTERS (in pharmacy) was the name formerly given to certain hydochlorates of the metals, such as antimony, arsenic, bismuth, tin, and zinc. Precipitated sulphur likewise was termed butter of sulphur. These designations are now nearly obsolete.

BUTTON-MANUFACTURE. This useful little appendage to dress is made of nearly every variety of material. Gold, silver, brass, copper, steel, iron, pewter, mother-o'-pearl, hard wood, bone, ivory, horn, leather, gutta-percha, vulcanised india-rubber, paper, glass, silk, wool, cotton, linen, thread, are all formed into buttons; and the manufacture is carried on very largely.

The varieties of buttons may be reduced to four, namely, 1, those *with shanks;* 2, those *without shanks;* 3, those on *wire moulds* (or rings); and 4, buttons *covered* with silk, cloth, or other material.

Metal buttons with shanks are generally punched out of a plate of brass having rather less zinc in its composition than ordinary brass. The discs so punched out, after having their edges trimmed to take off the burr, are ready for the shank. The shanks are made of wire by a most ingenious machine invented by Thomason of Birmingham. A coil of wire is placed in the machine, one end of which gradually advances to a point where a pair of shears cuts off a piece of the requisite length; a stud then presses against the middle of the piece and forces it between the two jaws of a vice into a staple-like form: the jaws compress it so as to form the eye of the shank; a little hammer then strikes the end and makes it level; and another movement finally drops it complete into a box. The shanks being placed upon the disc in their proper position, and kept there by a bent flat strip of iron, a small piece of solder is placed at the foot of the shank. In this state a hundred or more are put upon an iron plate and heated in an oven till the solder runs and fixes the shank. They are then turned separately in a lathe, the chuck of the lathe being so formed as to allow the buttons to be put in and taken out with great facility. The gilding is performed (or rather *was*, before the invention of electro-gilding) with an amalgam of gold and mercury, about the consistence of butter: five grains of gold are sufficient for a gross of buttons.

White metal buttons, such as those on soldiers' dresses, are cast in moulds, containing ten or twelve dozen, and the shanks are placed in the moulds previous to casting, so that when the buttons are cast the shanks are fixed at the same time.

Mother-o'-pearl buttons are cut out of the pearl shell by means of a small cylindrical saw, that is, a tube of steel with its edge cut into teeth. This tubular saw has a pulley on the tube, and is made to revolve rapidly after the manner of a lathe; the shell is pressed up against it, and thus the circular disc for the button is quickly cut out of the shell. The discs are turned in a lathe; and if the shell be thick, two are produced by splitting it. As the shanks cannot be soldered in, and they would not look neat if riveted through the button, a hole is turned about half way through, the hole being wider at the bottom than at the top, or, as it is called, dovetailed. The stem of the metal shank is just the size of the smallest part of the hole, and the stem is made a little hollow by drilling a conical hole up it, so as to leave the metal very thin at the edges. The shank being now put into the dove-tailed hole, a slight blow with the hammer spreads the thin edge of the stem under the dove-tailed edge of the hole; and thus the shank is firmly fixed. Mother-o'-pearl buttons are sometimes ornamented with eccentric circles, flutes radiating from the centre, &c., all of which are executed in the lathe by means of an eccentric chuck and slide rest.

Buttons without shanks are made of mother-o'-pearl, wood, bone, metal, &c., the metal ones being stamped and the rest turned. They have four holes through which the thread is passed to fix them on the garment. These holes are stamped in metal buttons, but they are drilled in those which are made of other materials. The holes are drilled while the buttons are in the lathe; four long drills are made to converge towards the button, and thus the four holes are all drilled at once.

Buttons on wire moulds are merely wire rings covered with thread by machinery which entwines the thread over the ring from its centre.

Covered buttons. Although many beautiful specimens of metal buttons have been produced by the manufacturers, still metal buttons may be said to be in great measure superseded by covered buttons. The stimulus being thus given, a great deal of ingenuity has been shown in the manufacture of covered buttons, and a number of patents have been obtained for the inventions: the following two plans will give a general idea of the principles of their construction. In one plan a metal disc is punched out of thin iron plate, which by subsequent punches has its edges turned up and then bent a little inwards: this is done to form the body of the button. Another smaller disc, capable of lying within the edges of the above, has a round or oval hole in the centre: this is to form the back. A circular piece of the stuff called florentine is then wrapped round the larger disc, and the edges are brought over and pressed into the hollow; the smaller disc or back is pressed into its place, and the turned-up edges of the face being compressed on the back, the whole becomes firmly fixed together; and the cloth protruding through the hole in the back affords the means of fixing it to the garment. In the other plan, which produces a very neat button, the disc for the body is left flat, and the back is a small circular disk with a round hole in the centre, but the outer edge is cut into eight sharp triangular points like a little star. These points are bent to a little less than a right angle to the disc, so that the points incline a little inwards. Besides these two metal discs, three pieces of paper and two pieces of cloth are necessary, so that the button consists of no less than seven separate pieces, which are put together in the following order:— 1st. On the piece of florentine which forms the outer covering is laid a piece of paper of the same size; on this the iron disc forming the body; on this another piece of paper the same size as the body; on this another piece of paper crumpled up into a little pellet to help to form the shank; on this a piece of coarse cloth; and finally the metal back. In putting on the back the florentine is gathered up over the whole of the materials, and then the points of the back are pressed into it; and as the points of the back are bent a little inwards (as was mentioned above), the consequence of the pressure is, that as they enter the cloth they bend more and more inwards, and thus form eight little *hooks* which very neatly and effectively hold the whole together. The little paper pellet makes the cloth protrude through the hole in the back, and forms the cloth shank by which it is attached to the coat. Almost the whole of these processes were originally performed by punches of various forms; but a patent was afterwards secured for a most ingenious machine to do the whole of the work. By placing two plates of iron, a roll of florentine, a roll of cloth, and three rolls of paper, and by setting the machine in motion, the whole of the seven parts of the button are cut out, put in their respective positions, and combined together into a perfect button.

A very beautiful and perfectly novel steel button was some years ago produced by Mr. Barton of the Royal Mint. It was intended for court dresses, being far too delicate and too expensive for ordinary purposes. By means of most accurate dividing machinery, a number of groups of fine lines are engraved on the button, the graving point being the splinter of a diamond: the machine is so accurate, that 10,000 lines can be drawn within the inch. The groups of lines may be disposed in triangles or hexagons, after the manner of a honeycomb, or in any other form at the option of the artist, or the lines may be made to cross each other in any direction. The pattern is comparatively of little importance, the beautiful effect being produced by the brilliant reflection of the light, which exhibits all the colours of the rainbow (on the principle of Newton's rings) in playful clouds like mother-o'-pearl, or in intense colour like the ruby or the emerald. This invention, however, never came extensively into use.

A singular method was introduced a few years ago, of imitating covered cloth buttons by a layer of flock, such as is used in paper

hangings. In the first place, thin sheets of metal are coated on one side with copal varnish thinned with turpentine, and coloured according to the colour of the flock to be employed. After being heated in an oven to 150° Fahr., and then allowed to cool, the surface is coated with a kind of paint formed of white lead, linseed oil, gold size, and colouring matter. While in this wet state, a quantity of flock is sifted over the surface, and allowed to remain on it twelve hours, by which time a film of flock will have adhered firmly to the metal. The loose flock being shaken off, the sheet is fitted to be cut up into collets or discs for the backs of buttons, to be made in the usual way.

Mr. Prosser's method of making buttons and other small articles of compressed clay was patented in 1840. Clay, clayey earth, or clay combined with a small portion of flint or felspar to give it hardness, is thoroughly dried and ground to a fine powder. The powder is passed through a sieve having about two thousand perforations in a square inch: all particles too large to pass through the perforations being rejected. For some coarser purposes a coarser sieve may be used. Buttons and other small articles are made of this powder by dies, or moulds, and a fly-press. The fly-press is firmly secured to a strong bed, or frame; and a die carrying on its under face the form in reverse (that is, hollow instead of relief), proposed to be given to the top of the button, is screwed to the follower of the press. A second tool or die of a kind of T shape, with an impress of the back of the button, fits loosely into a corresponding recess in the bolster. Below the press there is a treadle supported on a fulcrum near its centre, from one end of which a rod passes up through a small hole in the bolster to the lower die or tool. The hollow or recess in the bolster in which this tool rises and falls is of such a depth as to be an exact measure of the quantity of powder necessary for the formation of a button. The hollow in the mould being filled with powder, and the powder squared off to an exact level with the top of the mould, such power is applied to the press as will bring down the tool with a force of about 200 lb. on the square inch, upon the powder lying in the mould. The powder is by this means compressed into a very dense, hard, and durable substance, having on its surface the device imparted to it by the die. If the button is to have a metallic shank attached to it, a recess is formed at the back of the button for its reception, by a corresponding projection on the face of the lower die. If the button is to have holes similar to a brace-button, the dies must have such projections as will form these holes while the powder is being pressed into the mould. In the course of a year or two after this patent was obtained, no less than 5000 gross of these buttons were made weekly, at Minton's porcelain works in Staffordshire.

The Vicomte de Serionne took out a patent in 1850, for a somewhat complicated mode of making buttons, which should have a sort of crystalline appearance. They are made of felspar, basalt, lava pumice, granite, or flint. These minerals, or the one to be adopted, is reduced to powder, and made into a paste with salt and flour; the paste is pressed into a mould, of which the upper and under parts give the device to the button; and by subsequent modes of treating the surface, the button assumes either a transparency, or an agate-like opacity.

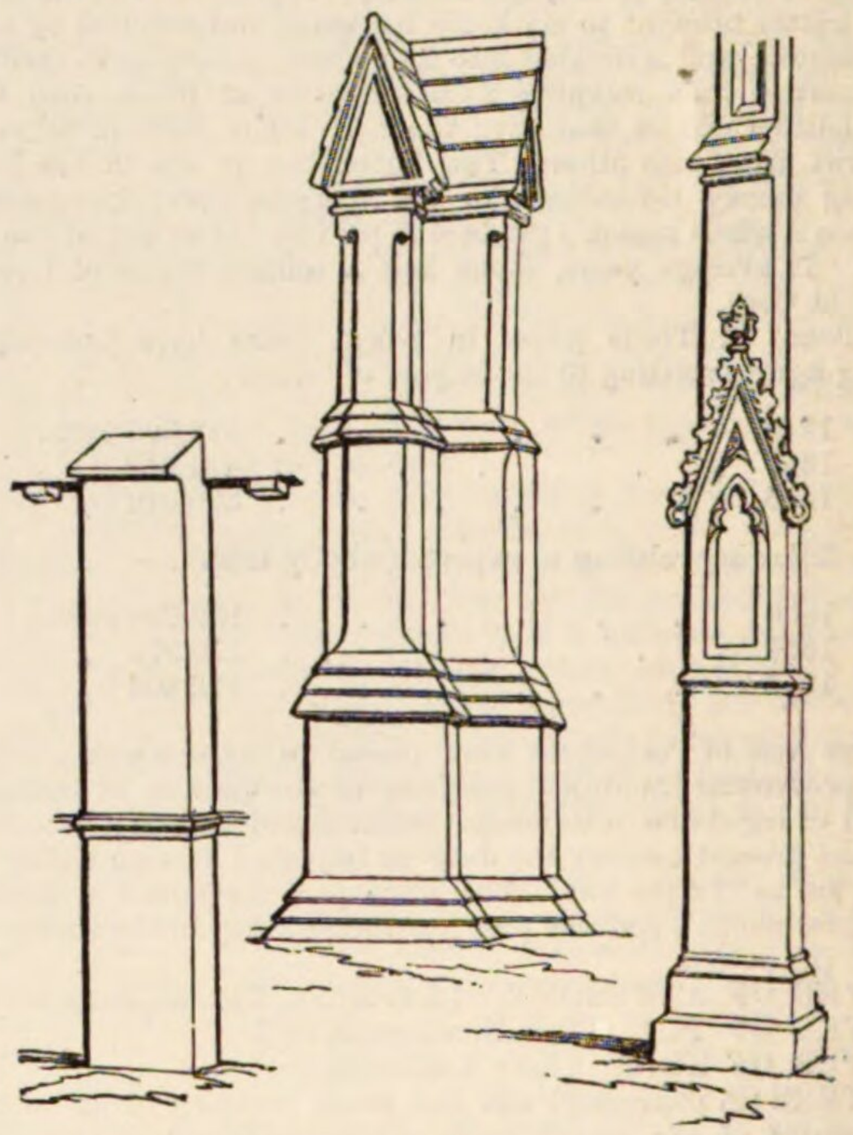
It would be quite useless to endeavour to describe the numerous patents for button-making introduced every year in England; they differ in points which, though important to manufacturers, are of little interest to general readers. One curious invention, patented a few years ago, was for ornamenting metal-buttons by printing a design from blocks or rollers, with an ink of sulphate of copper and tin, and then varnishing.

Birmingham is the great seat of the button manufacture in this country. By the census of 1851, there were 770 males under twenty years of age, 1350 above that age, 1265 females under twenty years of age, and 1595 of twenty years of age and upwards, a total of 4980 persons employed in that town; while the total number employed in the trade in England and Wales was but 2988 males and 3950 females of all ages; and in Scotland there were but 11 males and 4 females of all ages engaged in the manufacture.

BUTTRESS, a projecting support to the exterior of a wall, most commonly applied to churches in the Gothic style, but also to other buildings, and sometimes to mere walls. Buttresses, in the sense in which the term is commonly used, were not employed in Greek and Roman buildings, the external support being obtained by pilasters, or some other structural feature, to the presence of which, as an additional support, was given as little prominence as possible. Norman or Romanesque buttresses, which came into use probably from the time of the decay of Roman architecture, are plain broad faces, slightly projecting from the wall of the building to which they belong. In appearance they are very similar to the shaft of a pilaster, from which they most probably derive their origin. The top of these buttresses is terminated by an inclined plane or water-table, moulded underneath on the front face only. The bands which often occur in Norman buildings as a sort of capping to the basement of the wall are often continued round the sides of the buttress, thus making the lower part of the buttress as it were a pedestal to the upper part, or more properly to the pilaster. Unlike the buttresses of pointed architecture, those of the Norman period are not divided into stages diminishing in width as

they ascend, but continue of the same width to the top; and they are carried no higher than the cornice, under which they usually finish with a slope. In later Norman and transition buildings, buttresses are sometimes ornamented at the angles with columns, as at Castle Rising castle, Norfolk, Glastonbury Abbey, &c. But these decorations are sometimes of a later date. An additional resemblance to the Roman pilaster appears in these buttresses when they are found with a narrower face projected on the broader buttress. Castle Rising and Norwich castles contain good examples of Norman buttresses.

Of First Pointed or Early English buttresses, which immediately succeeded the former, Mr. Rickman distinguishes four kinds. The *first* is a flat buttress, narrower than the Norman, with mouldings more delicate, but very similar to, and hardly to be distinguished from the Norman. The *second* is a buttress projecting at times nearly as



A, Norman Buttress. B, Early English Buttress. C, Decorated English Buttress.

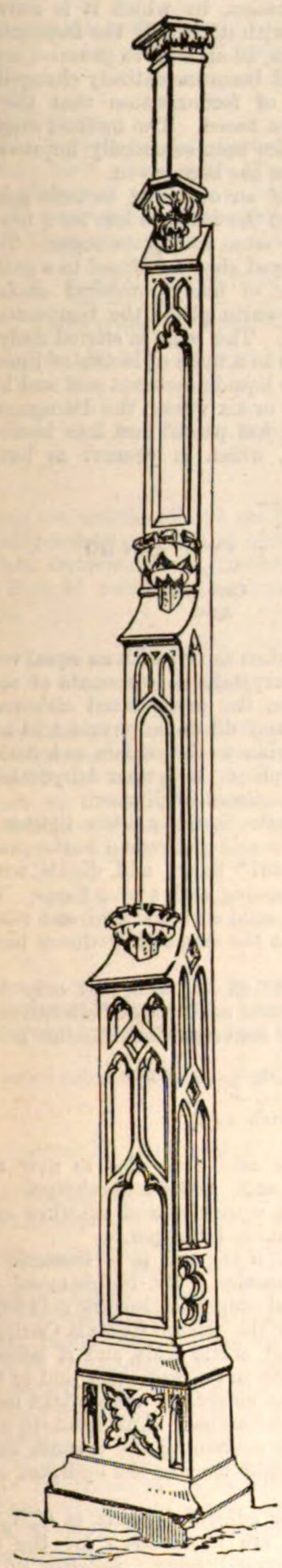
much as its breadth; at others, more than the breadth of the buttress. These buttresses sometimes are without set-offs, or have only one forming a division in the whole height. There are buttresses at Salisbury which belong to this class, and are highly enriched with niches and decorated with ornaments, but they have a very weak appearance. The *third* kind consists of long slender narrow buttresses, with a considerable projection, divided into several heights; they occur in some towers. The *fourth* kind of buttress of this period, and perhaps the latest, is divided into stages or divisions, receding one behind the other; but this also is not common. Like all the former, it is finished with a triangular, or rather acute-angled top, similar to the roof and gable ends of a building. These two last kinds are very similar in character.

Towards the close of this period, flying buttresses were first constructed, being thrown from the side aisle buttresses to the buttress of the nave and choir. Salisbury and Chichester cathedrals afford excellent examples; but flying buttresses did not become common till the next period of Gothic architecture. Early English buttresses have generally pyramidal tops; the sides of these buttresses are sometimes splayed at the edges, with pedestal-like bases. The shaft also is at times divided into one or more divisions, as at Lincoln. Occasionally the buttresses are very slender and carried up to a great height, becoming in fact rather ornamental features than supports, as at Beverley Minster, and the east end of All Saint's, Stamford. Beverley Minster has columns at the angles of the buttresses, with a niche in the pyramidal head.

The Middle Pointed or Decorated English buttresses which succeeded these, present many varieties; they exhibit some of the leading features of their predecessors, but are generally highly enriched. They are almost invariably divided into stages; are enriched with panels, niches, crocketed canopies, and, in large buildings, very frequently terminate in pinnacles. The triangular heads are commonly enriched with cusps. These buttresses, when used at the angles of buildings, are often applied diagonally to the angle, as at St. Mary Magdalene, Oxford. Examples of rich buttresses of the decorated style occur in the west front of York Minster; Exeter Cathedral; Malmesbury Abbey church; at the east end of Howden church, Yorkshire; at Bottisham, Cambridge-

shire; Redgrave, Suffolk; Gadsby, Leicestershire; and at the east end of Walsingham Priory. This last is almost in the perpendicular style, which immediately followed the decorated.

Third Pointed or Perpendicular English buttresses vary chiefly from those of the style which preceded them in that they are generally higher,

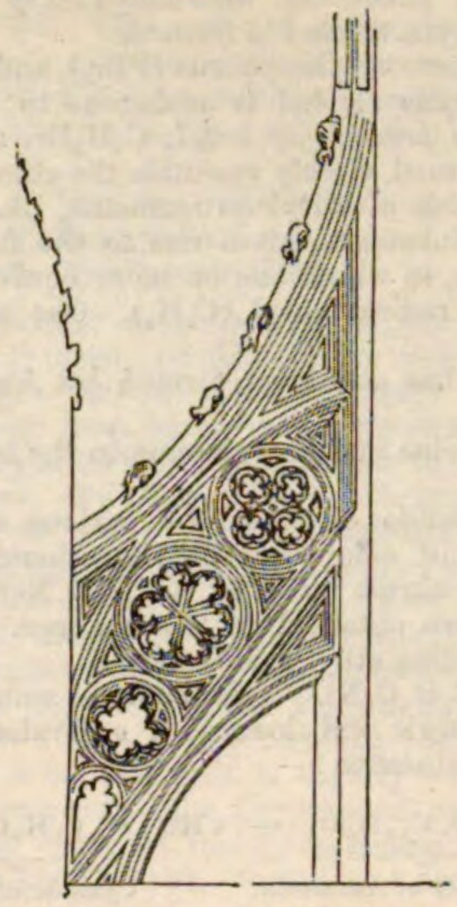


Perpendicular English Buttress.
Woolpit, Suffolk.

Decorated English Buttress.
Waltham Cross.

project more in proportion to their width, are of more numerous stages, are commonly panelled, and have the edges left sharp instead of, as hitherto, being chamfered. On the whole, however, they display less freedom of design. The heads of buttresses in the earlier part of this period are triangular, but are not acute-angled, as in those of the preceding century, and have crockets of very ornate character. In later examples, buttresses have sometimes flat terminations, which serve as pedestals for figures, as at King's College chapel, Cambridge; St. George's, Windsor; Beauchamp chapel, Warwick, and the Lady Chapel at Peterborough. Flying buttresses of extraordinary dimensions and elaborateness occur in French Gothic churches, as at Amiens, Rheims, St. Ouen, &c. Octagonal turrets are sometimes used as buttresses, as in Henry VII.'s chapel at Westminster, from which spring

the flying buttresses. The most superb of this kind ever executed in this country belong to this edifice.



Flying Buttress, from Henry VII.'s Chapel, Westminster.

(Ample details respecting buttresses will be found in Brandon's 'Analysis of Gothic Architecture;' Parker's 'Glossary;' the 'Dictionary of the Architectural Publication Society;' and the works of Britton, Bloxam, Pugin, Paley, Chapuy, De Caumont, Le Duc, &c.)

BUTYL (C_8H_9), *Valyl, tetryl.* The radical butyl was first discovered by Kolbe, among the substances produced by the electrolysis of valerianate of potash. Its formation is hence quite analogous to that of the radical methyl (C_2H_3), from acetate of potash. [METHYL.] It has also been obtained by Wurtz, by the action of potassium upon iodide of butyl. When pure, it is a limpid oil with an agreeable etherial odour, of the sp. gr. 0·694. It boils at 226° Fahr., and distils without alteration. It is only attacked with difficulty by oxidising agents. By the action of chlorine substitution products are formed.

Butyl is contained in a numerous family of organic substances, of which the following are the most important:—

Butylic alcohol $\left(\begin{matrix}C_8H_9\\H\end{matrix}\right\}O_2)$. This substance is a member of the series of homologous alcohols of which ordinary alcohol is the type, and the general formula for which is $CnHn+_2O_2$. It was discovered by Wurtz as a constituent in varying quantities in certain crude alcohols resulting from the fermentation of beetroot molasses. To obtain it, the crude alcohol is submitted to fractional distillation, and the distillate between 221° Fahr. and 239° Fahr. separately collected. This is then treated with potash and distilled, the distillate dehydrated over caustic lime, then re-distilled, and the product thus obtained rectified. What now passes over between 226° Fahr. and 230° Fahr. is pure butylic alcohol.

It is a colourless, highly-refracting liquid, with an odour resembling amylic alcohol, but more vinous. It has the sp. gr. 0·803, and it boils at 228° Fahr. It is more soluble in water than amylic alcohol.

Its formation from sugar may be thus expressed—

$$\underbrace{2(C_{12}H_{12}O_{12})}_{\text{Grape Sugar.}} = \underbrace{2(C_8H_{10}O_2)}_{\text{Butylic Alcohol.}} + 8\,CO_2 + 4\,HO$$

Butylic alcohol is homologous with common alcohol, and in its chemical relations and physical properties it presents, with regard to that substance, all the regular gradation of properties which characterises a true homologue, and accordingly we view it as containing the radical *butyl*, C_8H_9, of which it is the hydrated oxide (C_8H_9O,HO). [ALCOHOLS.] Like vinic alcohol it undergoes a series of changes under the influence of various reagents, and the substances produced bear the most perfect resemblance to those formed under the same circumstances from alcohol. It will not therefore be necessary to do more than briefly mention them.

When potassium acts upon butylic alcohol, hydrogen is liberated, and a crystalline product is obtained, *butylate of potash* (C_8H_9O,KO). By the action of soda-lime at a high temperature, hydrogen is liberated, and an alkaline butyrate is formed. Pentachloride of phosphorus attacks butylic alcohol energetically, and forms *chloride of butyl* (C_8H_9Cl), a colourless liquid of an etherial odour, which boils at about 160° Fahr.

$$\underbrace{C_8H_{10}O_2}_{\text{Butylic Alcohol.}} + \underbrace{PCl_5}_{\text{Pentachloride of Phosphorus.}} = HCl + \underbrace{C_8H_9Cl}_{\text{Chloride of Butyle.}} + \underbrace{PO_2Cl_3}_{\text{Oxychloride of Phosphorus.}}$$

This compound is also formed when butylic alcohol is treated with

hydrochloric acid. By the action of the chloride of butyl on sulphide of potassium, *sulphide of butyl* (C_8H_9S) is produced; and by its action on hydrosulphide of potassium, *hydrosulphate of butyl* (C_8H_9S,HS), the mercaptan of butylic alcohol is formed.

The action of bromide of phosphorus (PBr_5), and of iodide of phosphorus (PI_5), on butylic alcohol is analogous to that of chloride of phosphorus, and the *bromide of butyl*, C_8H_9Br, and *iodide of butyl*, C_8H_9I, which are formed, closely resemble the chloride.

The action of iodide of butyl on ammonia, like that of iodide of ethyl on the same substance, gives rise to the formation of various compound ammonias, in which one or more equivalents of hydrogen are replaced by the radical butyl (C_8H_9). One of these, *butylamine*, $C_8H_{11}N=N\left\{\begin{matrix}C_8H_9\\H\\H\end{matrix}\right.$, has also been formed by Anderson, along with ethylamine, methylamine, and propylamine, in the basic part of Dippel's animal oil.

By acting with iodide of butyl on various silver salts, Wurtz obtained a number of compound butylic ethers. The *carbonate of butyl* (C_8H_9O,CO_2), *nitrate of butyl* (C_8H_9O,NO_5), *acetate of butyl* ($C_8H_9O,C_4H_3O_3$), were obtained in this manner. They strongly resemble the corresponding ethyl compounds.

Cyanide of butyl ($C_8H_9C_2N$). Valerianate of ammonia, by the action of anhydrous phosphoric acid, loses four equivalents of water, and is converted into this substance :—

$$\underbrace{NH_4O,C_{10}H_9O_3}_{\text{Valerianate of Ammonia.}} - 4\,HO = \underbrace{C_8H_9C_2N}_{\text{Cyanide of Butyl.}}$$

It is also obtained, along with other products, by the oxidation of gelatine, and of caseine, by means of chromic acid. It is a colourless, highly refracting liquid, of a burning aromatic odour and bitter taste; its spec. gr. is 0·81, and it boils at 257° Fahr. In its chemical deportment it resembles the cyanides of the other alcohol radicals. By boiling with potash it is converted into valerianic acid and ammonia.

$$\underbrace{C_8H_9C_2N}_{\text{Cyanide of Butyl.}} + \underbrace{KO\,HO}_{\text{Potash.}} + 2HO = \underbrace{KO\,C_{10}H_9O_3}_{\text{Valerianate of Potash.}} + \underbrace{NH_3}_{\text{Ammonia.}}$$

By the careful addition of sulphuric acid to butylic alcohol, so as to avoid too great an increase of temperature, *sulphobutylic acid* ($C_8H_9O\,SO_3,HO\,SO_3$) is obtained, corresponding to sulphovinic acid. It forms salts which crystallise well, and bear the most striking resemblance to the sulphovinates.

If butylic alcohol be treated with excess of chloride of zinc, gaseous and liquid products are formed; the gases contain, among others, *butylene* (C_8H_8), homologous with olefiant gas, and *hydride of butyl* (C_8H_9H), homologous with hydride of ethyl.

Butylene has also been obtained by Faraday, among the products formed when fatty acids are passed through a red-hot tube. Kolbe also obtained it by the electrolysis of valerianate of potash. At the ordinary temperature it is a gas of the sp. gr. 1·926. It combines with chlorine in equal volumes, forming a colourless, limpid, aromatic liquid, which boils at 253° Fahr. Its formula is $C_8H_8Cl_2$; it is the chloride of butylene, and is homologous with the chloride of ethylene, or Dutch liquid, $C_4H_4Cl_2$. In its chemical deportment it perfectly resembles that substance. Bromine also combines with butylene, forming *bromide of butylene* ($C_8H_8Br_2$).

If, in the preparation of sulphobutylic acid, the temperature be not kept down, a violent reaction ensues, with the disengagement of sulphurous acid, and formation of various oily hydrocarbons, which appear to be polymeric with butylene.

Butylic ether $\left(\begin{matrix}C_8H_9\\C_8H_9\end{matrix}\right\}O_2)$ has not yet been prepared in a pure state. It is formed by the action of iodide of butyl on a solution of butylate of potash in butylic alcohol.

$$\underbrace{C_8H_9O,KO}_{\text{Butylate of Potash.}} + \underbrace{C_8H_9I}_{\text{Iodide of Butyl.}} = KI + 2\,\underbrace{C_8H_9O}_{\text{Butylic ether.}}$$

BUTYLAMINE. [BUTYL.]

BUTYLIC ALCOHOL. [BUTYL.]

BUTYLIC ETHER. [BUTYL.]

BUTYLIC GROUP. *Tetrylic Group*. This group of organic compounds belongs to the VALERIANIC SERIES. The principal substances contained in this group are described under the head of BUTYL.

BUTYLUREA. [UREA.]

BUTYRAL. [BUTYRIC ACID.]

BUTYRALDEHYDE. [BUTYRIC ACID.]

BUTYRAMIDE. [AMIDES; BUTYRIC ACID.]

BUTYRATES. [BUTYRIC ACID.]

BUTYRIC ACID $\left(\begin{matrix}C_8H_7O_2\\H\end{matrix}\right\}O_2)$. This substance occurs in nature both in the free state and in combination with bases. In butter it exists, in combination with glycerine, in the form of butyrine. This, which is a neutral substance, becomes decomposed on being kept for some time, more especially in a warm atmosphere, butyric acid being liberated, which then imparts to the butter its peculiar rancid odour. Butyric acid is a frequent product of the action of oxidising agents on organic substances, and it occurs not less frequently as a product of putrefaction and fermentation. Grape sugar, under certain circumstances, undergoes a peculiar fermentation, by which it is converted into a substance, lactic acid, isomeric with itself. If the fermentation, instead of being arrested at this stage, be allowed to proceed, another change takes place, and the lactic acid becomes entirely changed into butyric acid. It is on this process of fermentation that the best methods of preparing butyric acid are based. The method originally described by Pelouze and Gelis has since been essentially improved by Bensch, by whom the following process has been given.

Six pounds of cane sugar and half an ounce of tartaric acid are dissolved in 26 lb. of boiling water, and the mixture left for a few days to allow the cane sugar to become converted into grape sugar. To this mixture, about half a pound of decayed cheese diffused in a gallon of sour skim milk, together with 3 lb. of finely-powdered chalk, are added, and the whole exposed in a warm place, the temperature of which must not exceed 85°—95° Fahr. The mass is stirred daily, and generally solidifies in eight or ten days to a mass of lactate of lime. On standing, this gradually becomes more liquid; carbonic acid and hydrogen gases escape; and when, after five or six weeks, the disengagement of gas ceases, the whole of the sugar has passed first into lactic acid, and subsequently into butyric acid, which is present as butyrate of lime.

The change may be thus expressed :—

$$\underbrace{C_{12}H_{12}O_{12}}_{\text{Lactic Acid.}} = \underbrace{C_8H_8O_4}_{\text{Butyric Acid.}} + \underbrace{4\,CO_2}_{\text{Carbonic Acid.}} + 4\,HO$$

The solution of butyrate of lime is then mixed with an equal volume of water, and a solution of 8 lb. of crystallised carbonate of soda is added. The liquid is filtered off from the precipitated carbonate of lime, evaporated to a smaller bulk, and dilute sulphuric acid added. This liberates the butyric acid, which rises to the surface as a dark oily layer, and is removed by means of a siphon. It is then dehydrated by chloride of calcium, and purified by fractional distillation.

When pure it is a colourless, mobile liquid, a little lighter than water, with an odour at once like acetic acid and rancid butter, and an acrid and burning taste. It boils at 327° Fahr., and distils without change. Its vapour is inflammable, burning with a blue flame. When exposed to the great cold produced by solid carbonic acid and ether, it crystallises in large plates. It attacks the skin and produces blisters, like the most powerful acids.

It is not attacked by sulphuric acid in the cold, and only feebly when hot. Butyric acid dissolves in nitric acid without alteration, but by prolonged boiling it is oxidised, and converted into succinic acid.

$$\underbrace{C_8H_8O_4}_{\text{Butyric Acid.}} + 4O = \underbrace{C_8H_6O_6}_{\text{Succinic Acid.}} + 2\,HO$$

The action of chlorine on butyric acid gives rise to new acids, *Bichlorobutyric acid* ($C_8H_6Cl_2O_4$), and *Quadrichlorobutyric acid* ($C_8H_4Cl_4O_4$), which contain 2 and 4 equivalents of chlorine in the place of the same number of equivalents of hydrogen.

The formula of butyric acid is $C_8H_8O_4$, and it is isomeric with acetate of ethyl, and propionate of methyl. By its chemical composition and relations, and by its physical properties, butyric acid belongs to the series of volatile fatty acids of the general formula $CnHnO_4$— it is hence homologous with formic and acetic acids, and it bears the greatest resemblance to those acids, both in its properties, and in those of its compounds; the difference being no greater than might be predicated from its higher position in the series. Analogous to acetic acid we may consider butyric acid as containing the organic radical *butyryl* ($C_8H_7O_2$), and butyric acid would thus be the hydrated oxide of butyryl ($C_8H_7O_2O,HO$).

The butyrates are monobasic, their general formula is $C_8H_7MO_4$, or MO, $C_8H_7O_3$. When dry, they are inodorous: for the most part they are soluble in water and crystallisable. *Butyrate of soda* (NaO, $C_8H_7O_3$), and *butyrate of potash* ($KO\,C_8H_7O_3$) are deliquescent salts. *Butyrate of baryta* (BaO, $C_8H_7O_3+2$ aq) crystallises in long flattened prisms, perfectly transparent; when thrown on water, it assumes curious gyratory movements. *Butyrate of lime* (CaO, $C_8H_7O_3$) forms transparent fusible needles: it presents in water the same phenomena as the baryta salt. *Butyrate of copper* (CuO, $C_8H_7O_3$ + aq) forms beautiful green crystals of the monoclinic system.

Butyrate of ethyl, or *butyric ether* (C_4H_5O, $C_8H_7O_3$) is obtained by distilling a mixture of butyric acid, alcohol, and sulphuric acid. In a state of purity it is a colourless, inflammable liquid, with a peculiar odour resembling pine-apples. A solution of this ether in alcohol is used in confectionery under the name of *pine-apple oil*. The peculiar flavour of old rum is due to the presence of a small quantity of this ether.

Alkalies decompose butyric ether into a butyrate and free alcohol.

When agitated in a flask with ammonia for some time, it decomposes into alcohol, and *butyramide*.

$$\underbrace{C_{12}H_{12}O_4}_{\text{Butyrate of ethyl.}} + NH_3 = \underbrace{C_8H_9NO_2}_{\text{Butyramide.}} + \underbrace{C_4H_6O_2}_{\text{Alcohol.}}$$

Butyramide crystallises in brilliant white pearly tables. It is ammonia, in which 1 eq. of hydrogen is replaced by the radical butyryl $N\left\{\begin{matrix}H\\H\\C_8H_7O_2.\end{matrix}\right.$

When butyric acid is heated for some time with glycerine, combination takes place with elimination of water; according to the circumstances of the experiment, three different compounds may be formed, *monobutyrine*, *dibutyrine*, and *tributyrine*. Their formation may be thus expressed:

$$\underbrace{C_6H_8O_6}_{\text{Glycerine.}} + \underbrace{C_8H_8O_4}_{\text{Butyric Acid.}} - 2\,HO = \underbrace{C_{14}H_{14}O_8}_{\text{Monobutyrine.}}$$

$$C_6H_8O_6 + 2(C_8H_8O_4) - 4\,HO = \underbrace{C_{22}H_{20}O_{10}}_{\text{Dibutyrine.}}$$

$$C_6H_8O_6 + 3(C_8H_8O_4) - 6\,HO = \underbrace{C_{30}H_{26}O_{12}}_{\text{Tributyrine.}}$$

They are neutral oils of strong odour and pungent bitterish taste. Probably tributyrine is that which is present in butter.

When butyramide is treated with anhydrous phosphoric acid, it loses 2 eq. of water, and is converted into *butyronitrile* or *cyanide of propyl*.

$$\underbrace{C_8H_9NO_2}_{\text{Butyramide.}} - 2\,HO = \underbrace{C_6H_7C_2N}_{\text{Butyronitrile.}}$$

This is an oily liquid, boiling at 247° Fahr. It is also found among the products of oxidation of some organic substances.

Chloride of butyryl ($C_8H_7O_2Cl$), is prepared in an entirely analogous manner to the corresponding acetyl compound, by the action of oxychloride of phosphorus or butyrate of soda.

$$\underbrace{3(C_8H_7NaO_4)}_{\text{Butyrate of Soda.}} + \underbrace{PO_2Cl_3}_{\text{Oxychloride of Phosphorus.}} = \underbrace{3NaO,\,PO_5}_{\text{Tribasic Phosphate of Soda.}} + \underbrace{3(C_8H_7O_2Cl)}_{\text{Chloride of Butyryl.}}$$

It is a colourless, highly refracting liquid, heavier than water, and fuming strongly in the air. It boils at 203° Fahr. It decomposes with water into butyric acid, and hydrochloric acid. By ammonia it is converted into *butyramide* $\left(N\left\{\begin{matrix}C_8H_7O_2\\H\\H\end{matrix}\right.\right)$ and by analine in an analogous manner into *butyranilide* $C_{20}H_{13}NO_2 = N\left\{\begin{matrix}C_8H_7O_2\\C_{12}H_5\\H\end{matrix}\right.$ a substance which crystallises from alcohol in beautiful pearly laminæ.

By the action of chloride of butyryl on butyrate of soda, anhydrous butyric acid $\left(\begin{matrix}C_8H_7O_2\\C_8H_7O_2\end{matrix}\right\}O_2\Big)$ is formed. It is a colourless mobile highly refracting liquid, of a peculiar pleasant odour, lighter than water, by which it is slowly converted into hydrated butyric acid.

Two compounds are known which have the composition of the aldehyde of butyric acid. The one was obtained by Chancel among the products of the destructive distillation of butyrate of lime. These products may be separated by fractional distillation; the most volatile is *butyral*, a liquid boiling at 203° Fahr. It has the composition of butyric aldehyde ($C_8H_8O_2$), and many of the properties of an aldehyde; by oxidation it is converted into butyric acid, it reduces solutions of gold and silver, and combines with alkaline bisulphites; but it forms no definite compound with ammonia.

Butyraldehyde ($C_8H_7O_2H$). The true butyric aldehyde, or hydride of butyryl occurs among the products formed by the oxidation of caseine, albumen, and gelatine. It differs, from its isomer butyral, in its boiling point, which is between 158° and 167° Fahr., and in forming a very well defined compound with ammonia $\left.\begin{matrix}C_8H_7O_2\\NH_4\end{matrix}\right\}$

Butyrone ($C_{14}H_{14}O_2$), the keystone of the butyric series, was also obtained by Chevreul among the products of the destructive distillation of butyrate of lime. It is homologous with acetone and propione, and represents butyraldehyde in which 1 eq. of hydrogen is replaced by propyl $\left(\left.\begin{matrix}C_8H_7O_2\\C_6H_7\end{matrix}\right\}\right)$. It boils at 291° Fahr., and is oxidised by nitric acid to *nitropropionic acid* ($C_6H_5(NO_4)O_4$).

BUTYRIC ETHER. [Butyric Acid.]

BUTYRIC FERMENTATION. [Ferment.]

BUTYRIC GROUP. A family of organic compounds, belonging to the Butyric Series of Gerhardt's system of classification. The most important compounds belonging to this group are described under the head of Butyric Acid.

BUTYRIC SERIES. This series of organic compounds contains a number of bodies more or less closely related to one of the acids contained in rancid butter, and to which the name of butyric acid has been given. The butyric series comprehends the following three groups:—

1. Propylic or Tritylic Group.
2. Butyric Group.
3. Pyrotartaric Group.

BUTYRINE, a peculiar oleaginous matter, discovered by Chevreul, in butter, in which it exists combined with oleine and stearine, and a very small quantity of butyric acid. In order to prepare it, butter must be first separated from butter-milk by melting and pouring it off, and the butter thus purified is to be allowed to cool very slowly in a deep porcelain vessel, and then it is to be exposed for some days to a temperature of 66° Fahr.; by this treatment a large quantity of stearine is separated, crystallised in small grains, and an oily compound is obtained, which is to be carefully filtered, and then put into a glass vessel with an equal weight of alcohol of specific gravity 0·796, and kept at the temperature of 66°. The mixture is to be frequently shaken during 24 hours, and then the alcohol is to be poured off, and the insoluble portion set aside. By carefully distilling the alcohol, an oil rich in butyrine is left, but as it is slightly acid it is to be treated with carbonate of magnesia: the butyrate of magnesia thus formed being very soluble in water, is rapidly separated; the remaining fatty matter is then to be treated with alcohol, and this being distilled the butyrine is left pure.

The properties of butyrine are, that at 66° it is very fluid, and it congeals at about 32°. Its smell resembles that of heated butter. It is generally yellowish, but this colour is not essential, for some kinds of butter yield it almost colourless. Its specific gravity is 0·908; it is insoluble in water; but alcohol of specific gravity 0·822, when boiling, dissolves it in all proportions. When two parts of butyrine are combined with ten parts of boiling alcohol, the mixture on cooling becomes turbid; but when twelve parts of butyrine are similarly treated with the same quantity of alcohol, the mixture remains transparent even after it has become cold. During distillation the alcoholic solution becomes very slightly acid; and the residue contains traces of butyric acid. Butyrine readily saponifies, and is then converted into glycerine, and butyric, capric, caproic, margaric, and oleic acids.

The substance thus obtained from butter is obviously a mixture, but the recent researches of Berthollet have shown that pure butyrine may be prepared by passing a current of hydrochloric acid gas into a mixture of butyric acid and glycerine; according to the conditions of the experiment, one or other of the following compounds is formed [Butyric Acid]:—

Monobutyrine	$C_{14}H_{14}O_8$
Dibutyrine	$C_{22}H_{20}O_{10}$
Tributyrine	$C_{30}H_{26}O_{12}$

BUTYRONE. [Butyric Acid.]

BUTYRONITRYL. [Butyric Acid.]

BUTYRUREIDE. [Urea.]

BUTYRYL. [Butyric Acid.]

BUTYRYL, HYDRATED OXIDE OF. [Butyric Acid.]

BU'XINE, a vegetable alkaloid obtained from the box-tree (*Buxus sempervirens*). It is difficult to procure this substance colourless; and it has generally the appearance of a translucid deep brown-coloured mass. Its taste is bitter, it excites sneezing, and is insoluble in water, but is dissolved in small quantity by alcohol and ether. It acts as other alkalies on reddened litmus paper, and forms neutral salts with the acids, which are more bitter than the base itself; and the solutions give gelatinous white precipitates with potash. Sulphate of buxine crystallises confusedly. This alkaloid is contained in every part of the box-tree, and the bark gives nearly one per cent. of it.

BUXTON WATERS. The waters of Buxton belong to the northern or Derbyshire thermal springs, which have a lower temperature than those of the southern or Gloucestershire and Somersetshire group, except Bristol. They are of the calcareous class of mineral waters, and rise in a valley situated on the west edge of the great limestone range, which extends through the county of Derby from Castleton southwards, comprising what is termed the Peak Forest. The surface of this district is occupied, according to Farey, by the outcrop of four strata of limestone and three beds of amygdaloid or toadstone, interposed between the limestone strata; but it should be observed that this division of the limestone by regular beds of toadstone has been stoutly denied, and at present is not generally received. Above the upper stratum of limestone is a coarse sandstone or millstone grit, considered by many as the inferior bed of the coal formation, which occupies the whole country E. and N. of this district. Buxton is immediately to the S. of the outgoing of the lowest stratum of limestone. The limestone, which is of a whitish or yellowish colour, is full of encrinites, madrepores, and other organic remains. The direction of the strata is generally N. and S. A remarkable fault is observed in the valley of the Derwent, at Matlock; the upper bed of limestone on

the W. side of the valley is brought down below the second bed on the E., and the upper bed of toadstone on the one side is nearly on the same level with the second bed on the other. The fault is said to extend N. as far as Buxton, where it takes a N.W. direction to North Bradwell, and terminates at Litton near Tideswell; but both the direction and extent of this fault have been much disputed. It is in the course of this fault that the thermal springs of Buxton and Matlock are found. That of Buxton possesses the higher temperature, namely, 82° Fahr., which never varies at any hour of the day or season of the year. This water has been long celebrated for its medicinal virtues. It is more remarkable for the nature of its gaseous impregnations than for the quantity or nature of its saline ingredients.

"The following analysis gives the amount and nature of the solid ingredients in one imperial gallon of the water, at 60° :—

	Grains.
Silica	0·666
Oxide of iron and alumina	0·240
Carbonate of lime	7·773
Sulphate of lime	2·323
Carbonate of magnesia	4·543
Chloride of magnesium	0·114
Chloride of sodium	2·420
Chloride of potassium	2·500
Fluorine (as fluoride of calcium)	a trace
Phosphoric acid (as phosphate of lime)	a trace
	20·579

On examining the water, there were found present carbonic acid and nitrogen, in addition to the solid ingredients. One gallon of the water was found to contain altogether 13·164 grains of carbonic acid; but of this quantity, 5·762 grains were due to the carbonates of lime and magnesia, and therefore only 7·402 grains could be considered free. The carbonates of lime and magnesia are present as bicarbonates, or as carbonates dissolved in carbonic acid, and 5·762 grains of carbonic acid would require to be added for this purpose. Hence, of the 7·402 grains, or 15·66 cubic inches, of gaseous carbonic acid in the water, only 1·640 grain, or 3·47 cubic inches, can be considered free and uncombined. The nitrogen in the water could only be present in solution, and not in combination. The gas therefore consists entirely of carbonic acid and nitrogen, with a trace of oxygen accidentally present. It is assumed that at the moment of issue, the water is charged with 20·6 inches of nitrogen, and 15·66 inches of carbonic acid." (Dr. Lyon Playfair, in Dr. Wm. Henry Robertson's 'Handbook to the Peak of Derbyshire,' London, 1854, Bradbury & Evans.)

Owing to the quantity of calcareous matter, the water is hard. It sparkles a little when first received at the fount. It is exceedingly clear, and does not become turbid by long exposure to the air. Over the bath a stratum of vapour hovers, which is more or less dense according to the state of the weather and the degree of attention paid to the ventilation of the apartment. The chalybeate spring contains about half a grain of carbonate of iron in each gallon, and is a soft water.

The waters issuing from the warm spring are employed both internally and externally. A course of the water internally is generally taken at the same time as the baths are used; but in some habits of body the one mode only is admissible. Persons of the sanguineous temperament, especially if plethoric, can rarely take the waters internally, without at least previously undergoing some preparatory treatment,—either venesection, cupping, or the use of purgative medicines. During all acute inflammatory diseases they must be avoided; and though very beneficial to persons subject to gout and rheumatism, the waters must not be employed either when an attack of the disease is approaching, or while much pain of the joints remains when the disease is receding. Persons in whom the digestive organs are feeble, either naturally or from the effects of what is termed *good living*, derive, in general, much benefit from the internal use of these waters. In most cases they should be taken early in the morning, after the bath, if these two modes be employed simultaneously. The quantity to be used should not at first exceed half a pint, taken in two equal portions, a quarter of an hour (during which the invalid will walk along the terrace when practicable) being allowed to intervene between the two glasses. About noon the same quantity should be again taken, observing similar rules. Some patients are however obliged to restrict themselves to its use during the forenoon, omitting the morning dose. No one should exceed a pint and a half in the course of each day.

The chalybeate water is sometimes used at the same time, and it is said that a mixture of the two forms a purgative draught. Upon the propriety of using the chalybeate at any period during his stay, the invalid must consult his medical adviser on the spot. It ought never to be used as a common drink, more particularly by persons of a plethoric habit of body.

The warm baths may be employed even by the most delicate persons, provided bathing in any form be proper. At first the stay in the bath should not exceed one minute, as the plunge is the most beneficial part of the process. The time may be gradually extended, but should never exceed fifteen minutes. Where a general bath cannot be borne by gouty or rheumatic patients, pumping the water upon the affected joints is frequently highly efficacious in reducing the swelling and restoring flexibility. During the use of the baths no mercurial medicines of any kind should be taken, unless under the direction of a competent medical adviser on the spot.

(Farey's *Derbyshire;* Gairdner on *Mineral Springs;* Denman, Saunders, Scudamore.)

BYLAW. Bylaws are the private regulations of a society or corporation, agreed upon by the major part of its members, for purposes of self-government, or for more conveniently carrying into effect the object of its institution.

It is not every voluntary association to which the law of England gives the power of binding dissentient members by the enactments of the majority. Immemorial custom or prescription, or legal incorporation by the crown, or by or under the provisions of a statute, is necessary to confer this power of local or private legislation; and even in those cases the Courts of law exercise the right of discussing the validity or policy of the bylaw, and of establishing its legality or declaring it to be void. In order to stand this test it must be reasonable and agreeable to the general policy of the law of England, and must not attempt to bind strangers unconnected with the society, or to impose a pecuniary charge without a fair equivalent, or to create a monopoly, or to subject the freedom of trade to undue restraint. The general object of a bylaw is thus rather to regulate existing rights than to introduce new ones or to extinguish or restrain the old. And where authority to make such regulations is conferred by charter or statute, the powers to do so must be strictly followed in making it, or the bylaw itself will be void.

The power of making bylaws is not absolutely confined to corporate bodies. It is in some instances lawfully exercised by a class of persons having no strict corporate character. Thus the tenants of a manor, the jury of a court-leet, the inns of court, the inhabitants of a town, or other district, sometimes enjoy a limited legislative power of this kind, by special custom or common usage. But in general the power is exercised only by incorporated bodies, and in such bodies the power is inherent of common right without any specific provision for that purpose in the charter of their incorporation. The expediency of this power is so obvious that we cannot be surprised at meeting with proofs of its existence in all countries and at a very early date. The Roman code recognised a right among the confraternity of its corporations to bind one another by similar engagements, as long as they were not at variance with the public law ('Dig.,' lib. xlvii. tit. 22), and professes to borrow this provision from the still more ancient code of Solon.

Our own term *bylaw* is of Saxon origin, and is formed by prefixing to the word *law* another word *by* or *bye*, which means *house* or *town*. Hence its primary import is *town-law*, and in this form and with this meaning it is said to be found among the ancient Goths, the Swedes, the Danes, and other nations of Teutonic descent. (Cowel, voc. 'Bilaws;' Spelman on 'Feuds,' chap. ii., and the Glossaries under the head 'Bilago,' or 'Bellago.')

The *birlaws* and *birlaw courts* of Scotland, mentioned by some of the jurists of that country, are said to present some analogies to our bylaws, and may perhaps be referred to the same origin.

The statutes regulating municipal corporations give to the town councils a power of making bylaws for the good rule and government of the boroughs, and for the suppression of various nuisances; and of enforcing the observance of them by fines limited to 5*l*. The local boards of health, the trustees of turnpike-roads in public matters, railway, canal, and dock companies within their own limits, have also limited powers of making bylaws enforceable by penalties. Some joint-stock companies possess analogous authority for the proper carrying on their own business, and the regulation of their own affairs.

BYSSUS (*βύσσος*). It has been a subject of some dispute whether the byssus of the ancients was cotton or linen: but recent investigations have determined that it is linen, and not cotton; at least so far as the term has been applied by Greek and Roman writers to mummy-cloth. Herodotus states, that the Egyptians wrapped their dead in the cloth of the byssus; and it has been shown by microscopic observations, that every specimen of mummy-cloth yet examined is made of linen fibre. The name byssus came probably from the Phœnicians, and may be derived from בּוּץ butz. (Buxtorf's 'Lexicon.') It is possible that writers later than the time of Herodotus may sometimes have applied the term indifferently either to cotton or linen cloth. Cotton was known in the time of Herodotus (B.C. 484—408), who calls it tree-wool (*εἴριονἀπον ἀπὸ ξύλου*): but there is no evidence to prove that it was then cultivated in Egypt, or in any other country except India; or that it was in common use in Egypt. His remarks, so far as they go, seem to imply that the commodity was a rarity. ('Library of Entertaining Knowledge;' 'Egyptian Antiquities,' cap. v., vol. ii., part. i.)

BYZANTINE ARCHITECTURE is that style of ecclesiastical architecture which originated in Byzantium (Constantinople), and was employed throughout the middle ages by the architects of the Greek church. Before the separation of the Eastern from the Western empire, architecture had fallen into a very debased condition. But in Roman architecture, even in its lowest state of declension, there existed the germs of new and noble forms. As was said under ARCHITECTURE, all true architecture has been the result of a modification or adaptation of some previous system to present circumstances and requirements. When, therefore, the growth of the Christian Church called for build-

ings adapted to its ritual, and corresponding to the dignity and wealth of the worshippers, the early ecclesiastical architects turned to the architecture of Rome, the only architecture with which they were acquainted, and found the guidance they sought. Their earlier works were of necessity to a great extent imitative; but as they acquired mastery over their art, and came to understand more exactly what was required, they applied their examples with more and more freedom, until they had, probably almost unconsciously, invented or rather developed a new style of architecture. In the Western empire, Roman architecture became in the hands of the ecclesiastical architects what is now known as the Romanesque. This, as it spread through Italy, Germany, France, and England, was variously modified into what we are sometimes apt to speak of as distinct styles under the names of the Lombardic, Norman, &c.; its ultimate development being into the Gothic. In the Eastern empire, on the other hand, Roman architecture became what we have now to notice as the Byzantine type, which in its turn influenced, more or less, all subsequent Oriental architecture, as well as that of the Slavonic races, and, by way of Venice and Marseille, extended its branches into Italy, the South of France, and even Germany.

The origin of Byzantine architecture dates from the foundation of Constantinople by Constantine in A.D. 328. Nothing was omitted which the imperial power as well as the imperial wealth could accomplish, in order to impart magnificence to the city which was not only to serve as the metropolis of the East, but to bear the emperor's own name, and to convey to posterity a due impression of his genius and his power. The ablest architects and the most skilful artificers were summoned from the capital of the West to raise the capital of the East; and the cities of Greece and Asia were despoiled of their most valuable ornaments to contribute to its splendour. Gibbon has collected from a wide range of authorities a striking account of the enthusiasm and the rapacity of the emperor, and the splendour of the new city. ('Decline and Fall,' chap. xvii.) It is not necessary to follow him in the enumeration of the public halls, theatres, baths, porticoes, aqueducts, palaces, temples, and churches which were erected. Probably constructed hastily, and with a view to gorgeousness of effect, they possessed little originality of character, or even correctness of imitation. We are told, indeed, that "the impatience of Constantine soon discovered that, in the decline of the arts, the skill as well as number of his architects bore a very unequal proportion to the greatness of his designs." And that in consequence, "the magistrates of the most distant provinces were directed to institute schools, to appoint professors, and by the hopes of rewards and privileges, to engage in the study and practice of architecture a sufficient number of ingenious youths, who had received a liberal education." (Gibbon.) In this step we perhaps may discover the true foundation of the new style. Young men thus impressed, as it were, from all parts, and trained with a view to meet an urgent requirement, would be far more likely to regard their art with a practical eye, to consider how they could best adapt the edifices they had to construct, so as to fulfil the purposes for which they were to be erected, and employ the materials at hand, rather than to encumber their minds with questions of precedence and academic propriety. And hence, in the churches the character and requirements of the ritual, and the arrangements called for by climate and the habits of the worshippers, would be studiously considered; and thus a style would be gradually formed like that actually found to exist—traceable back to the debased Roman of the 3rd century, but impregnated with a decided Orientalism of thought and well adapted, as it is generally admitted to be, to the locality in which it originated, and to the service of the Greek Church.

Of this First Period of Byzantine architecture which is considered to extend over a couple of centuries, from about 330 to 500, there are, however, few, if any, examples remaining which enable us to trace the actual progress of the style. The church of St. Johannes, constructed in the middle of the 5th century, is perhaps the oldest remaining in Constantinople. It shows that the Roman influence was still dominant. It is basilican in form [Basilica], unlike the true Byzantine church, which always is, or approximates to, that of the Greek cross. The columns are imitations of a classic type, the order being Corinthian. Ample illustrations of this church will be found in the magnificent work of Herr Salzenberg, cited below. Other examples of this period are the church of St. John at Salonica, that of the Holy Sepulchre at Jerusalem, &c. As far as present investigations have shown, it may however be said that during this, its First Period, Byzantine architecture, with some local peculiarities, is essentially the same as the contemporary Romanesque.

The Second Period is, however, that of Byzantine architecture proper. It dates from the time of Justinian, who may indeed be regarded as its founder. The grand characteristic of the true Byzantine style is its use of domes and cupolas. A Byzantine or Greek church, in plan a Greek cross, consists of a great central square covered by a dome, other parts being covered by semi-domes or cupolas; west of the dome is a spacious extension called the narthex, while the east end terminates in a triple apsis. The interior consists of five divisions: 1, the *narthex* (western porch or vestibule), which is set apart for catechumens—the ground-floor being devoted to males, the gallery to females; 2, the *nave*, separated from the narthex by a screen, and from (3) the *choir*, usually by a low wooden barrier; 4, the *bema*, or sanctuary; and 5, the *apsis* (usually tripartite), which forms the holiest place, and is shut off from the bema by a wooden screen which reaches to the roof or ceiling: this screen is called the Iconastasis (Εἰκόνασταsις) from the sacred pictures which are on its panels. Three doors in this screen lead from the bema to the apsis.

Externally Byzantine churches of this period exhibit little splendour. Columns are beginning to be a subservient and merely decorative feature. The capitals are little more than square blocks, tapering downwards, the ornament being either basket-work or foliage, and like the ornament generally in very low relief—the ground of the ornament being sunk below the general surface: sometimes disconnected volutes occur in their proper places, but occasionally at the bottom of the capitals. The arches are semi-circular. The domes and semi-domes, or cupolas, rise from nearly flat roofs. The great pillars which bear the central dome, are square; and pendentives [Dome], first adopted in the church of Sta. Sophia, are employed with great skill. The domes are for the most part pierced at their bases with numerous windows; the great dome of Sta. Sophia has 40. Coloured marbles are used for the shafts and other internal features, and rich mosaics are freely employed: the architects evidently trusting largely to polychromatic decoration for their general effect.

The most important example of this period, the typical example indeed of pure Byzantine architecture, is the church of Sta. Sophia at Constantinople (now, as is well-known, a Mohammedan mosque, the Aya Sofia), built in 532, by the emperor Justinian. Gibbon's account of its erection and of the building itself is so admirable that, though the passage be long, it will be more satisfactory to quote it than to give a dry technical description. He says:—

"The principal church, which was dedicated by the founder of Constantinople to Saint Sophia, or the Eternal Wisdom, had been twice destroyed by fire; after the exile of John Chrysostom, and during the *nika* of the blue and green factions. (January, 532.) . . . . . But at the end of forty days a new temple was strenuously undertaken by the piety of Justinian. . . . . Anthemius formed the design, and his genius directed the hands of ten thousand workmen, whose payment in pieces of fine silver was never delayed beyond the evening. The emperor himself, clad in a linen tunic, surveyed each day their rapid progress, and encouraged their diligence by his familiarity, his zeal, and his rewards. The new cathedral of St. Sophia was consecrated by the patriarch, five years eleven months and ten days from the first foundation; and in the midst of the solemn festival, Justinian exclaimed with devout vanity, 'Glory be to God, who hath thought me worthy to accomplish so great a work; I have vanquished thee, O Solomon!' But the pride of the Roman Solomon, before twenty years had elapsed, was humbled by an earthquake, which overthrew the eastern part of the dome. Its splendour was again restored by the perseverance of the same prince; and in the thirty-sixth year of his reign, Justinian celebrated the second dedication of a temple, which remains, after twelve centuries, a stately monument of his fame. . . . . The dome of St. Sophia, illuminated by four-and-twenty [40] windows, is formed with so small a curve that the depth is equal only to one-sixth of its diameter; the measure of that diameter is 115 feet, and the lofty centre, where a cresent has supplanted the cross, rises to the perpendicular height of 180 feet above the pavement. The circle which encompasses the dome, lightly reposes on four strong arches, and their weight is firmly supported by four massy piles [piers], whose strength is assisted on the northern and southern sides by four columns of Egyptian granite. A Greek cross, inscribed in a quadrangle, represents the form of the edifice; the exact breadth is 243 feet, and 269 may be assigned for the extreme length from the sanctuary in the east to the nine western doors which open into the vestibule, and thence into the *narthex*, or exterior portico. . . . . Beyond the northern and southern piles, a balustrade, terminated on either side by the thrones of the emperor and the patriarch, divided the nave from the choir; and the space [bema] as far as the steps of the altar, was occupied by the clergy and singers. The altar itself, a name which insensibly became familiar to Christian ears, was placed in the eastern recess [the apsis] artificially built in the form of a demi-cylinder; and this sanctuary communicated by several doors with the sacristy, the vestry, the baptistery, and the contiguous buildings, subservient either to the pomp of worship or the private use of the ecclesiastical ministers. The memory of past calamities inspired Justinian with a wise resolution, that no wood, except for the doors, should be admitted into the new edifice; and the choice of the materials was applied to the strength, the lightness, or the splendour of the respective parts. The solid piles [piers] which sustained the cupola were composed of huge blocks of freestone, hewn into squares and triangles, fortified by circles of iron, and firmly cemented by the infusion of lead and quicklime; but the weight of the cupola was diminished by the levity of its substance, which consists either of pumice-stone that floats in the water, or of bricks from the Isle of Rhodes five times less ponderous than the ordinary sort. The whole frame of the edifice was constructed of brick; but those base materials were concealed by a crust of marble; and the inside of St. Sophia, the cupola, the two larger and the six smaller semi-domes, the walls, the hundred columns, and the pavement delight even the eyes of barbarians with a rich and variegated picture. A poet, who beheld the primitive lustre of St. Sophia, enumerates the colours, the shades, and the spots of ten or

twelve marbles, jaspers, and porphyries, which nature had profusely diversified, and which were blended and contrasted, as it were, by a skilful painter. The triumph of Christ was adorned with the last spoils of paganism; but the greater part of these costly stones was extracted from the quarries of Asia Minor, the isles and continent of Greece, Egypt, Africa, and Gaul. Eight columns of porphyry, which Aurelian had placed in the temple of the Sun, were offered by the piety of a Roman matron; eight others of green marble were presented by the ambitious zeal of the magistrates of Ephesus: both are admirable by their size and beauty, but every order of architecture disclaims their fantastic capitals. A variety of ornaments and figures was curiously expressed in Mosaic; and the images of Christ, of the Virgin, of saints, and of angels, which have been defaced by Turkish fanaticism, were dangerously exposed to the superstition of the Greeks. According to the sanctity of each object, the precious metals were distributed in thin leaves or in solid masses. The balustrade of the choir, the capitals of the pillars, the ornaments of the doors and galleries, were of gilt bronze; the spectator was dazzled by the glittering aspect of the cupola; the sanctuary contained 40,000 pound weight of silver; and the holy vases and vestments of the altar were of the purest gold, enriched with inestimable gems. Before the structure of the church had risen two cubits above the ground, 45,200 pounds were already consumed, and the whole expense amounted to 320,000 pounds: each reader, according to the measure of his belief, may estimate their value either in gold or silver, but the sum of one million pounds sterling is the result of the lowest computation." ('Decline and Fall,' ch. xi.)

More strictly architectural descriptions of this remarkable building, in its present as well as in its ancient state, will be found in the works referred to below, especially those of Fossati and Salzenberg: the former had the rare advantage of studying it quite unrestrained, he having been employed by the Sultan (or rather the minister Reschid Pacha) to repair and in part restore the building. Salzenberg's work is one of the most beautiful architectural monographs yet published. As will have been noticed, Gibbon, with all his warmth of description, speaks disparagingly of Sta. Sophia as a work of art. Of late years a different opinion has been gaining ground; M. Fossati, who has spent so much time in its study, may easily be regarded as enthusiastic when he expatiates on the "majesty of the *ensemble* and the perfection of the details" of "this grand architectural master-piece," and asserts that he "knows not any other monument in the world the proportions of which are so vast and so majestic;" but it is otherwise when we find the interior of Sta. Sophia held forth by a high authority in our own country as the finest domical interior of ancient or modern times, both for appropriateness and beauty; while, it is added, "if we regard it with a view to the purposes of Protestant worship, it affords an infinitely better model for imitation than anything our own mediæval architects ever produced." (Fergusson, 'Handbook of Arch.,' ii. 951.) Without going as far as this, there can be no doubt that a careful study of Byzantine interiors, with those of our own Wren, would have been far more beneficial to Protestant church architecture than the unreasoning imitation of Gothic forms which has so generally prevailed of late years, even whilst retaining Gothic as the basis of our ecclesiastical style.

The church of SS. Sergios and Bacchos, or as it is commonly called the lesser Sta. Sophia, is another very admirable, but smaller and less gorgeous, example of this period yet remaining at Constantinople; its central dome is 47 feet in diameter. St. Irene (now used as a museum for antique arms) is still smaller, but has some interesting features. Salzenberg gives illustrations of both these churches.

The Third Period extends from about 800 to 1200, when Byzantine architecture proper may be considered to have expired: in the period between the taking of Constantinople by the Venetians (1204) and its final conquest by the Turks (1453), such art as existed having become corrupted by the admixture of various foreign and incongruous elements.

In this Third Period, while the interiors are still adorned in as costly and splendid a manner as possible, more ornament is expended upon the exterior of the building than in the preceding, and more Orientalism

of character is imparted to the general design. The domes and semi-domes are much smaller, and are raised on cylinders which reach to the height of the windows, so that the curved part is less than a hemisphere. Coloured shafts and flat surface decorations are much employed on the outside of the buildings. All the churches of this period in Constantinople are much inferior in size, as well as in richness, to Sta. Sophia. The finest remaining is that of Sta. Theotokos (9th century), which is, however, only 45 feet by 37 in the interior (exclusive of the narthex), with a central dome only 14 feet in diameter, but having three other domes over the narthex of scarcely inferior dimensions. The church of S. Pantokrator, founded in the beginning of the 12th century, is a kind of triple church, the central one having, as is believed, been intended as the sepulchre of the founder.

But the noblest example of the Byzantine architecture of this period is the church of St. Mark at Venice, which, begun in 977, was not finally completed till the latter part of the 12th century. Venice at this time belonged rather to the Eastern than to the Western empire, and the architects of the new church were brought from Greece, as were later the workers in mosaic; but whether the design was from Constantinople or Alexandria, is by no means certain. The plan of the church is a Greek cross, which is crowned with a central and four other domes, of equal diameters. The interior is 205 feet long; the transepts are 164 feet; but the external dimensions are 264 feet by 215. It is built of brick, but veneered on the exterior with marble. Much has been added to the church since its erection, and many of the original features have been concealed by subsequent alterations. Much of the ornamentation of the western front, and the peculiar cupola-like terminations which now surmount the domes, are of considerably later date, and belong to quite a different architectural style. Still the work retains the true Byzantine character, especially in the interior, which is unique in the "truly Byzantine profusion of gold mosaics which cover every part of the walls above the height of the capitals of the columns, and are spread over every part of the vaults and domes; being, in fact, the real and essential decoration of the church, to which the architecture is entirely subordinate. Externally, its great beauty consists in the profusion of marble columns, which surround and fill all the front and lateral porches. Like those in the interior, they have no constructive office to fulfil, but they are in themselves rich and beautiful, and are most picturesquely disposed." (Fergusson.)

The church of St. Antony at Padua bears a considerable resemblance to St. Mark's, but has a central dome, and five other domes over the nave, transepts, and choir, and two slender towers; it is, however, not so purely Byzantine in character, and much less graceful in form. A much closer imitation, though wanting the splendour of St. Mark's, is the church of St. Front at Périgueux, which M. de Verneilh assigns to the beginning of the 11th century. Another very important church of this period, usually termed Byzantine, is the cathedral of Pisa, which, with its connected baptistery, campanile, and campo santo, forms one of the most striking architectural groups in Europe. But though it has much that is Byzantine in character, it has so much that is Romanesque, that it cannot perhaps be fairly classed as Byzantine. Its architect was, however, a Greek, Buschetto of Dulichio, who erected it in the beginning of the 11th century.

For other true Byzantine churches in Greece, Asia Minor, Italy, France, &c., and for fuller particulars respecting the style itself, we must refer the reader to the works cited below, only remarking that, as in the instance of Pisa, it is now generally felt that some of the authors who have specially written on the subject have been led by their enthusiasm to extend Byzantine influence much farther than a cooler and more searching investigation warrants.

(A. Couchaud, *Choix d'Églises Byzantines en Grèce*, fol. Paris, 1842; G. Fossati, *Aya Sofia Constantinople, as recently restored by order of H. M. the Sultan Abdul Medjid*, fol. London, 1852; W. Salzenberg, *Alt-Christliche Baudenkmale von Constantinopel*, fol. Berlin, 1854; Neale, *History of the Holy Eastern Church*, London, 1850; F. de Verneilh, *L'Architecture Byzantine en France*, Paris, 1851; De Caumont, *Cours*, vol. iv.; Hope, *Hist. of Architecture*; Fergusson, *Handbook of Architecture*; &c.)

C

C. This letter is derived from the Latin alphabet, in which it first appears. But even in that alphabet it originally possessed the power of *g*, as pronounced in *goose*. Thus the Roman proper names *Caius* and *Cneius*, which retained this sound, are correctly represented in the Greek character by *Gaios* and *Gnaios*; and the Duilian inscription presents *macestratus, leciones, pucnandod, ecfociont*, in the place of the modern forms, *magistratus, legiones, pugnando, ecfugiunt*. Indeed the poet Ausonius expressly states that C once performed the duty of G: *Gammæ vice functa prius* C. (See also Festus, *vv. Prodigia, Orcum.*) This medial pronunciation corresponds with the power of the letters which occupy the third place in the Greek and Hebrew alphabets, *gamma* and *gimel*; and the identity of the letters is confirmed by the similarity of the forms. [ALPHABET.]

The letter *c* in English is pronounced as *s* before *i, e*, and as *k* before *a, o, u*. This variety in the power of the letter seems difficult to account for; but it may be observed that *i, e*, belong to one end of the vowel series, *a, o, u*, to the other [ALPHABET]; and it is further to be noticed that the vowels *i* and *e*, when they precede vowels, have a power approaching to that of *y* in *youth*, and that if in addition to this, *c* or *g* precede, there often results a sound like that at the beginning of the words *church* and *John*, and this sound of *ch* is not very different from a sibilant. The vowels *i* and *e* produce a similar sound when preceded by *d* or *t*, and followed as before by a vowel. Thus from *ratio* the Italians have obtained *ragione*; and from *radio, raggio*; from Diana the rustics of Italy made Jana. These considerations are perhaps supported by the employment of the little mark called *cedilla* in the French language, which is used to denote that *c* is to be pronounced as *s* even before the other vowels, as *ça*; for the mark appears to have been originally an *i*. The connexion of the sounds *k* and *s* will be again spoken of.

The letter *c*, when pronounced as in *cat*, belongs to the order of guttural or throat letters, and among these it is distinguished by that character which grammarians have denoted by the Latin word *tenuis*, "thin." The correct distinction of the letters called *tenues*, as opposed to those which bear the name of *medials*, is perhaps this, that in the pronunciation of the *tenues p, k, t*, the organs employed in articulation have only a small portion of their surfaces brought into contact, and that but for a short time; while in the articulation of *b, g, d*, the surface in contact is more extensive and the effort less rapid.

The letter *c* is liable to the following interchanges: 1. In the derivation of French words from the Latin, *c* before *a* is changed into *cha* or *che*; ex., the Lat. *camera*, a vaulted chamber, *castus*, chaste, &c., *carus*, dear, *cadere*, to fall, *casa*, cottage, appear in French under the forms, *chambre, chaste*, &c., *cher, cheoir, chez*, &c. In this way the English language has derived *channel, chivalry, charnel, chattels*, through the French from the Latin *canalis, caballus, caro* (*carnis*), *capitalia*; and at the same time possesses the words *canal, cavalry*, or *cavalcade, carnival, cattle*, derived from the same roots, but by a different route. In the *patois* prevailing in the N.E. of France, the sound of the *k* still remains in these words, *chemin* being pronounced *kemin, chat* as *cat*.

2. The change of *c* into *ch* prepares us in some measure for that of *c* into *s*, as Lat. *facimus*, we do, Fr. *faisons*; Lat. *placere, licere*, Fr. *plaisir, loisir*, Eng. *pleasure, leisure*. This interchange of *c* and *s* is strongly exemplified in the comparison of the Western languages of Europe with those lying towards the East. Thus we have in Latin, *canis*, dog; *conca*, shell; *centum*, hundred; *decem*, ten; *cannabis*, hemp: in Greek, *kuon* (κυων), *konche* (κογχη), *hekaton* (ἑκατον), *deka* (δεκα), *kannabis* (κανναβις); in Sanskrit, *savan, sanca, sata, dasan, sana*; and in Russian, the forms for *calamus, cor, centum, canis*, are *soloma, serdtse, sott, sobūka*. It should be stated, however, that the *s* in the Sanskrit alphabet, which is thus convertible with the *k* of the West, is a letter of a peculiar character, and is marked by a distinct symbol. Even Herodotus has observed (ix. 20) that the commander of the Persian cavalry, Masistios, was called by the Greeks Makistios, and the same interchange may occasionally be seen in the Teutonic languages, as in the German *faust* and *fechten*, Eng. *fist* and *fight*, words as certainly related as the Latin *pugnare* and *pugnus*. The pronunciation of the Latin *c* as an *s* in such words as Cicero, Cæsar, is proved to be incorrect by the Greek equivalents *Kikeron* (Κικερων), *Kaisar* (Καισαρ), and no less so by the co-existence of such forms as *acer, acris*; and it would be trifling to defend the pronunciation by the accidental identity in form of the Roman *c* and one of the many symbols for the Greek sigma. [ALPHABET.]

3. *C* initial of the Latin language corresponds to *h* in the German. Compare *collum, hals*, neck; *celare, hehlen*, hide; *cutis, haut*, hide; *cannabis, hanf*, hemp; *canis, hund*, hound; *cornu, horn*, horn; *calamus, halm*, stalk; *caput, haupt*, head; *cor* (*cord*) *herz*, heart; *crates, horte*, hurdle. Traces of the same change are visible within the Latin itself, as *traho, traxi* (*trac-si*); *veho, vexi* (*vec-si*); and the town of Apulia, called by Strabo Kerdonia, is called by Roman writers Herdonia. So the Greeks had *ossos* (οσσος), an eye, while the Romans preferred *oculus*.

4. *C* is convertible with *v* and *w*. This may be seen in the related forms *Dacus, Davus; focus, foveo; nix, nivis; conniveo, connixi; lacus, lavo; vivo, vixi; struo, struxi*. Thus too the English* *quick* (the original meaning of which is seen in the phrases "the quick and the dead," "the quick of the nail,") is identical with the Latin *vivus*; and we have another remarkable example in the derivation of our words *eleven* and *twelve* from the Latin *undecim, duodecim*. [See L.]

5. *C* into *g*. The change already mentioned of the power of the Roman symbol *c* is a sufficient proof of this. We may add *eager, meagre*, derived through the French *aigre, maigre*, from the Latin *acer, macer*. The old meaning of *eager* in Shakspeare is sharp, sour, as *eager milk*; and indeed the word appears again in *vinegar, vinaigre*. So too *aveugle*, blind, must have come from a Latin word, *aboculus*. The same change appears in the Teutonic. To the Latin *oculus* corresponds the German *auge*; to *duc-o, zog* and *zug*; while the Latin *lacr-uma*, or Greek *dakr-yon*, has in Gothic the form *tagr*, a tear.

6. The interchange of *c* with *p* is most remarkable in the Greek and Latin languages, the former commonly preferring the labial. Gr. *pepo*, Lat. *coquo*, cook; Gr. *leipo*, Lat. *linquo*, leave; Gr. *pipto* (or rather *pi-pet-o*), Lat. *cad-o*, fall, &c. The same interchange appears within Italy itself; the pigeon in Rome was called *columba*, the pigeon out of Rome, that is the wild pigeon, was called *palumba*; so *proximus*, nearest, has supplanted *propsimus*, from *prope*, near. The Latin word *quicquid* was pronounced by an Oscan as *pitpit*, and Augustus, we are told by Suetonius (Octav. 88), cashiered an officer for his ignorance in spelling *ipse* with an *x*.† This convertibility of the *tenues* extends to the letter *t*. Thus we find *scapula* and *spatula* both conveying the notion of a *blade*. The Greek *tetartos*, fourth, *tis*, who, *te*, and, appear in Latin as *quartus, quis, que*. The old name of the rock of Gibraltar assumes the various forms, *Calpe, Carpe, Carte, Tarte*. And in English we have *nut*, from Lat. *nux* (*cs*); and, on the other hand, *cork* from *cort-ex*.

7. Latin words beginning with *cu* have often lost the guttural. Thus *ubi* occupies the place of *cubi*, an old dative of the relative (compare *sicubi, alicubi*, &c.); *uter* of *cuter* (compare the Greek *koteros*), *umquam* of *cumquam* (compare together *quis, cum, quisquam*). This variety appears in our own tongue, where *which*, formerly *whilk*, was once written *quwhilk*.

8. *C* often disappears before *l* and *n*. This naturally arises from the difficulty of pronunciation, as in *knee*, Lat. *genu*; *know*, Lat. *gno-sco*; thus from the old Frank name Clodovick are derived Clovis, Louis, Ludovicus, Ludwig, Lovick.

9. In the derivation of Italian and French words from the Latin, *c* disappears before a *t*, the preceding vowel being commonly strengthened, as Lat. *dictus*, said, It. *ditto*, Fr. *dit*; Lat. *coctus*, cooked, It. *cotto* (whence *terra cotta*), Fr. *cuit* (whence *bis-cuit*, twice baked). It also disappears at times before an *r*, as in Lat. *sacramentum*, oath, Fr. *serment*; Lat. *lacrima*, a tear, Fr. *larme*. Lastly, the same fate awaits it when flanked on either side by vowels; compare the Latin *locus, jocus, focus, paucum, vices, apicula, corbicula, oculus, nocere*, &c., with the French *lieu, jeu, feu, peu, fois, abeille, corbeille, œil, nuire*, &c.

C is the Latin symbol for a hundred. Whether it is so used as being the first letter of *centum*, a hundred, may be doubted. [NUMERALS.]

CABAL is often applied to a set of persons, too insignificant in point of number to form a party, who endeavour to effect their purposes by underhand means. The ministers of Charles II., Clifford, Ashley, Buckingham, Arlington, and Lauderdale, the initials of whose names happen to form the word cabal, were appropriately called the "Cabal Ministry.' The word "cabal" appears to 'come from the French *cabale*, a term employed to express a number of persons acting in concert; and it is generally understood in a bad sense. (Richelet.) It was, however, used in our language a considerable time before the formation of the Cabal Ministry mentioned above.

CABBAGE. There are several species of the genus *Brassica*, or cabbage, which comprehends the *turnip*, the *rape*, the *cole*, and the common culinary cabbage, or *Brassica oleracea*. The innumerable varieties arise from difference of soil and cultivation; and as all the cabbage tribe form hybrids, new varieties are continually produced. This is effected by the bees, when different sorts are in flower at the same time. The pollen adheres to their body as they seek honey in the flowers, and being deposited on the pistils of other sorts, impregnates the germen. Hence only one variety of cabbage should be

* In some of the provinces of England 'wick' is used in the sense of quick. A thing that is alive is said to be 'wick.'

† In our own language we have *rock* (Fr. *roche*), from the Latin *rupes*, *scum* (Fr. *écume*) from *spuma*.

in flower at the same time in any garden or field, when we wish to keep the sort unadulterated; particularly if some sorts have expanded leaves, and others close heads. It is thus only that the excellent small miniature cabbage which grows on the stem of the Brussels' sprout, can be kept in perfection. The different sorts of cabbages most prized for the garden are chiefly divided into the close-hearting and the spreading. Of the first, the York and the Savoys are the most common; of the latter, the cole-worts and Scotch kale.

In order to have a regular succession of cabbages the seed should be sown at different times, from the beginning of spring to the autumn. The early sown will run to seed the same year; the later sown will increase more, produce larger and firmer heads, and will not go to seed till the next season. Some sorts, it is said, will continue to produce leaves for several years, if they are regularly taken off, and if the seed-stem is prevented from shooting by cutting it down as soon as it begins to appear. Thus a perennial cabbage-tree is produced, which yields abundance of food for sheep and cattle.

Cabbage plants are generally raised first in a seed-bed; when they are intended for early produce they are sown before winter, and protected by shelter or under glass frames. In this manner strong plants may be had early in spring, which planted out in April will produce fine cabbages by July or August. Those which are raised on a large scale are generally sown in March, and planted where they are to remain in June or July. When they have been pricked out from the seed-bed very young, and allowed to get to a good size in a piece of ground prepared for the purpose before being finally transplanted in the field, the success is more certain, and it will well repay the additional trouble. These come to perfection in autumn, and may be taken off the ground as they are wanted. Some kinds are so hardy that they will bear the severest frosts, and remain covered with snow for a considerable time without damage. Such are the green curly-leaved cabbages, or Scotch kale, which form no close head, but consist of spreading leaves. The great portion of nutritive matter in the leaves and stems of cabbages has made them an important object of cultivation wherever much cattle is kept, and where the land is favourable to their growth.

The cultivation of cabbages is the same in the field as in the garden, except that on a large scale less attention is paid to each plant, and the spade is superseded by the plough, and other instruments. A good and rather stiff loam is best adapted to cabbages. They require a considerable portion of manure if the land is not naturally rich, or if they are cultivated as a part of a regular rotation. There is no vegetable which produces so large a portion of food for cattle on the same space as the cabbage, provided the soil suits its growth. Though it impoverishes the ground, this should not prevent its being extensively cultivated, provided the nourishment it produces compensates for the additional manure required. The great advantage in the cultivation of the cabbage is, that a great portion of its substance is restored to the ground in all well-regulated farming establishments, in the shape of the dung and urine of the cattle fed upon them. It is asserted by experienced agriculturists that in this respect it is superior to the common turnip. The cultivation of the cabbage on a large scale is by no means so general on the soils well adapted to them as might be wished. This is probably owing to the trouble of transplanting, and the occasional failure of the plants in very dry weather. But the trouble and expense may be greatly diminished by attention and method. The plants may be raised in such abundance, by having a regular garden for the purpose, that they may be transplanted at various times, and the plants placed so thick as to allow for failures, whilst those which are superfluous may be hoed out. The cause of failure is generally in the careless manner of planting. Holes are usually made in the ground with some blunt instrument, the plants are put in without its being noticed whether the roots are doubled up or straight, whether the earth is pressed close to the roots, or vacancies are left between them and the soil, in which case they cannot take root properly.

If seed be sown in the garden in March, the plants will be ready to be dibbled in the field in May and June, and fit for consumption in autumn. It is well to prick out the young plants in lines before finally transplanting them in the field. In this last process the plough may be used. The ground having been well prepared, and being in good heart and tilth, a deep and narrow furrow should be opened. The plants having been carefully taken up without breaking the fibres of the root, the tops should be cut off to about six inches from the the crown, women and children should then go along the furrow with baskets in which the plants are carefully laid, and place them, at the distance of eighteen inches or two feet from each other, against the earth which has been just turned over by the plough, so that the bottom of the roots shall lie along the newly made ridge, and the crown of the plant be on a level with the surface of the ground; a slight push will make it adhere to the fresh soil. If some rich mould is mixed with drainings of the dung-hill or ditch water to the consistency of soft mud, and the root of each plant is dipped in a pail of this mixture immediately before planting, the plants will seldom fail. The plough in returning covers all these roots with the earth of the next furrow; and a man follows and presses his foot obliquely against the furrow slice at the place where the head of the plant appears. The plough then takes two shallower and broader furrows, or leaves a space of two feet between the last-made furrow, and forms another in which plants are again placed and covered up as before. The rows will thus be three feet wide. If the cabbages are of a large sort every alternate plant may afterwards be cut out, either as soon as they are fairly rooted, or when they have acquired a moderate size; in which case they will afford excellent food for cows and pigs, although not sufficient to stall cattle upon. The repeated use of the plough and horse-hoe between the rows is necessary for the growth of the cabbages, as well as highly useful to clean the land. By this mode of cultivation much labour is saved, the risk of the failure of the plants is greatly diminished, and if the ground has been well prepared and sufficiently manured, an astonishing weight of solid food for cattle is obtained. The best sort to plant in the field is the large drum-head cabbage. Should the ground be of great fertility, and at the same time compact, the large Strasburg cabbage, which grows to the weight of 60 lbs. and even 80 lbs., will produce an enormous weight of food. This cabbage is common in Germany.

When given to cattle or sheep, cabbages should be sliced in the same manner as turnips or beet-root. When milch cows are fed with them, all the decayed leaves should be carefully taken off and given to store cattle or pigs; for these are the chief cause of the bad taste which the milk and butter acquire from this food. [Butter.] For bullocks cabbages and oil-cake are excellent food, and increase their flesh rapidly. For sheep they should be sliced and given to them in troughs in the field where the cabbages grow, or on grass-land which requires to be manured. In England the sorts which have a close head are preferred; but where labour is abundant and forage scarce, as in France, the branching sorts are thought more profitable, because the leaves may be taken off repeatedly and will grow again. The thousand-headed cabbage, and the large cabbage of Poitou, as well as the tall cabbage, called *chou cavalier*, which grows with a stem six feet high, and gives large broad leaves without any close head, are greatly preferred in France to the sorts which bear close heads.

Cabbages are subject to a peculiar disease when repeatedly planted in the same ground: the bottom of the stem enlarges, and the plant becomes sickly. This disease is called *clubbing*, and is occasioned by an insect, which deposits its eggs in the substance of the stem where it joins the root: the organisation of the plant is deranged, and the cabbages never come to perfection. The only remedy for this disease is to change the cultivation, and for a time to plant no cabbages on the ground which produces clubbed plants, but to trench it up well, and expose it to the winter's frost in ridges: quick-lime should be put on it, but no manure; and other vegetables of a different class should be sown for two or three years. After this it may be considered as purified, and cabbages may safely be planted there again. In the fields, where cabbages do not return so frequently on the same ground, this disease is seldom found. The depredations of caterpillars and slugs are sometimes very great; the only means of prevention is to pick them off as soon as they appear: ducks and fowls in this case are excellent helps, the former especially, for clearing the ground of slugs.

In Germany there is an immense consumption of the large white cabbage in the form of the national mess, called *saur kraut*. This is prepared in the following manner: The cabbages are sliced thin by hand, or by a machine like a turnip-slicer, of the same kind as that by which French beans are sliced in Holland. [Bean.] The bottom of a cask, of which the head has been taken out, is covered with salt, and a layer of thin-sliced cabbage six inches thick is laid over it; on this a quantity of salt is spread, and another layer of cabbage mixed with some juniper-berries and whole pepper; and thus salt and cabbage alternately until the cask is filled. A round board is then put into the cask so as nearly to fit it, and on this a heavy weight of stone or metal is laid. As the cabbage ferments and sinks, the cask is filled up with fresh salt and cabbage. After some time the expressed juice is poured off, some water with salt dissolved in it is poured over, and changed until it ceases to rise with a scum and fetid smell; the cabbage is then in a fit state to be kept. A cloth is laid over it, and over this the round board and weights. When any portion is taken out for use, a sufficient portion of brine is allowed to remain over the mass to exclude the air; and the cloth, board, and weights, are replaced as long as any cabbage remains. This *saur kraut*, when washed with soft water and stewed with bacon or salted meat, is a very wholesome dish, and much relished by those who have been early accustomed to it. In long voyages it has been found to be an admirable preservative against the sea-scurvy.

CA'BBALA. "The Jewish Cabbala," says Dr. Henry More, in the preface to his 'Conjectura Cabbalistica,' "is conceived to be a traditional doctrine or exposition of the Pentateuch, which Moses received from the mouth of God while he was on the mount with him. And this sense, or interpretation, of the law or Pentateuch, as it is a doctrine received by Moses first, and then from him by Joshua, and from Joshua by the seventy elders, and so on, was called *Cabbala* from קִבֵּל, *kibbel*, *to receive*. But, as it was delivered as well as received, it was called *Masora*, which signifies a *Tradition;* though this latter more properly respects that critical and grammatical skill of the learned among the Jews, and therefore was profitable for the explaining the literal sense, as well as that more mysterious meaning of the text where it was

intended." In a wider sense, however, the Cabbala is used for the whole secret or esoteric philosophy of the Jewish doctors—a subject of great extent and intricacy, upon which voluminous works have been produced, both by Rabbinical and Christian writers. The most celebrated collection of the Rabbinical writings on the Cabbala is the work entitled 'Kabbala Denudata, seu Doctrina Hebræorum Transcendentalis,' &c., 3 vols. 4to. Sulzbach, 1676, and Frankfort, 1684. The editor of this work, which is a very rare book, the third volume in particular, is believed to be Christianus Knorrius à Rosenroth. Lists of the Rabbinical treatises on the Cabbala may be found in Wolf's 'Bibliotheca Hebræa,' and in the 'Bibliotheca' Magna 'Rabbinica' of Bartoloccius and Imbonatus. Of the Christian writers on the Cabbala, the most famous are Picus of Mirandola, the younger Van Helmont, and his friend Dr. Henry More, the learned and eloquent English Platonist who, in his 'Conjectura Cabbalistica,' is earnest in its defence. Mosheim, on the contrary, says it was the doctrines of Greek paganism accommodated to the Jewish religion; that it was fruitful of errors, destructive of the very foundation of Judaism, that it produced many of the Gnostic heresies, and that it taught that the dominion of the supreme God was to be destroyed by the expected Messiah. There is a valuable article on the Cabbala by the Abbé Mallet, in the great French 'Encyclopédie.' A short popular account of this philosophy is given by the Marquis le Gendre in the 7th chapter of the third book of his 'Traité de l'Opinion.' The celebrated work of the Abbé de Villars, entitled 'Le Comte de Gabalis,' from which Pope avows that he took the machinery of sylphs and gnomes in his 'Rape of the Lock,' is a satire upon the mystical absurdities of the Jewish Cabbala. Bayle has noticed that the substance of this work is contained in the first two of ten letters attributed to the charlatan Joseph Francis Borri, and published at Geneva in 1681, under the title of his 'Chiave del Gabinetto' (Key of the Cabinet). [Art. 'Borri' note G.] Although the letters in question are dated at Copenhagen in 1666, there can be little doubt that they were stolen from the work of the Abbé de Villars, which was first printed in 1670.

CABIN, a term applied to the inclosed portions of a ship, in which her officers or passengers reside. A careful arrangement of cabins in Her Majesty's navy contributes much to the comfort and health of the occupants; while in the merchant service a judicious division of space in passenger ships finds special favour with the public. In large vessels of war the admiral's and captain's cabins extend across the ship near her stern, and they are usually divided into two, termed the *fore* and *after* cabins; the latter are considered more strictly private, while the former are used for dinner, for the reception of strangers, and other purposes. The cabins of the senior commissioned officers are generally upon the main deck; and each receives light and ventilation from a port, commonly having a heavy gun thereat; such cabins being at each side of the great "mess-cabin" or "ward-room," while the cabins of the others and "gun-room" officers are placed along each side of the lower or orlop-deck, near the water level, and are only partially lighted from a scuttle or stout glass bull's-eye in the ship's side. It is to the space between these cabins (called the "cockpit") that in battle the wounded are conveyed for medical help. The mess-cabin called the "gun-room" is usually on the deck below the ward-room.

In frigates the captain's cabin is on the main-deck, and the gun-room, or after part of the lower deck, is given to the officers; but in two-decked line-of-battle ships, the captain takes the cabin under the poop, and the officers the great cabin on the upper gun-deck. In three-deckers the ward-room is appropriated to the admiral, and the officers take the corresponding one on the middle gun-deck. The partitions by which all these cabins are enclosed are called *bulk-heads*, and are composed of light panelled frames, which are instantly removable when the decks are ordered to be cleared for action. In the merchant service totally different and greatly diversified arrangements exist. In large passenger-ships, a spacious and often grand saloon, fitted with taste and expense, offers to the voyager, in its luxurious couches, sofas, &c., the, personal comforts of a drawing-room; while the gorgeous gildings and mouldings, and the various artifices and devices of the "decorator," are calculated to remind the traveller of the elegance of his home, even be that home a palace.

CABI'RI (Καβεῖροι), ancient Pelasgian divinities, belonging to a system of elementary religion, which, in the later ages of Greece, was connected with the celebration of mysterious rites in the island of Samothrace. According to Strabo (p. 472), who quotes Stesimbrotus, they derived their name from Mount Cabeirus in Berecynthia. They were apparently the same as the Corybantes, &c. (Strabo, pp. 466, 472; *Schol. on* Aristoph. 'Pac.' 277), and their worship was most cultivated in Samothrace, Lemnos, Imbros, and certain towns of Troas. (Strabo, p. 473.) Their names were mystical, and are given by Mnaseas. (*Schol.* Apoll. Rh. i. 917.) Camilus, Cumilus or Cadmilus, was the son of Hephæstus and Cabeira, and his children were the three Cabeiri, from whom came the nymphs Cabeirades (Acusilaus, *ap.* Strab. p. 472). Camilus is stated to have been the same as Hermes, and the three Cabeiri mentioned by Mnaseas, Axieres, Axiocersa, and Axiocersus, are said to correspond to Ceres, Proserpine, and Pluto, respectively. It seems more probable, howeve, that Camilus represented the generative principle (Herod. ii. 51), and that the three Cabeiri were personifications of Love, the male and the female, the first part of each name being the epithet ἄξιος (worthy), which is very frequently applied to gods, and the remaining parts, Eros, Kersos, and Kersa, having the significations which we have assigned to them. (*κέρσης, γάμος*, Hesych.) Of the rites themselves very little is known. They appear to have been solemnised annually, and to have lasted nine days. Samothrace was the principal seat of the worship; but caberia, as the rites were called, appear to have been held at Samnos and Imbros, though some ancient writers assert that the rites in these places differed from those at Samothrace. All who took part in these underwent purification prior to admission, and they were strictly prohibited from divulging what they witnessed. The reader who is desirous of investigating this ancient religion may consult Creuzer's 'Symbolik' (ii. p. 318); Müller's 'Orchom.' (p. 450); Welcker's 'Trilogie;' Lobeck's 'Aglaoph.' (lib. iii. c. 6); Haupt's 'Religione Cabiriaca;' and Schelling's 'Treatise on the Samothracian Mysteries.' The images of the Cabiri were pigmy statues, of which there are specimens among the terra-cottas of the British Museum (Combe, no. 42). As the son of Vulcan, Cabeirus or Cadmilus is represented with a hammer in his hand. (Winckelmann, ii. p. 507.)

CABLE. [Ground Tackle.]

CABLE, CHAIN. [Ground Tackle.]

CABRIOLETS, PUBLIC. [Stage Carriages.]

CACAO, or, as it is commonly called, Cocoa, is the bruised seeds of the *Theobroma cacao*, a tree belonging to the natural order *Sterculiaceæ*. The seeds are oval, about as large as an olive, obtuse at each end, compressed, and covered with a violet or ash-gray skin, which encloses two irregularly-cut and plaited cotyledons, of a fatty nature, and of a brownish-black or violet colour. The properties of these seeds are owing to the presence of a fixed concrete oil and an agreeable aromatic principle. Simply bruised they constitute the cocoa of the shops; reduced to a paste, mixed with sugar, and flavoured with vanilla, they become chocolate. [Chocolate.] They are imported from several of the West India islands, from Caracas, from Guayaquil, from Brazil, in all which places the tree grows wild, or is cultivated for the sake of its seeds. For a description of the tree and its mode of culture see Theobroma, in Nat. Hist. Div.

The quantities of cacao imported into and consumed in this country in the years 1857 and 1858, were –

	Imported.	Consumed.
1857 . . .	7,343,458 lbs.	3,762,594 lbs.
1858	7,256,520	2,777,194

CACHET, LETTRES DE, were letters proceeding from and signed by the kings of France, and countersigned by a secretary of state. They were called also "lettres closes, or "sealed letters," to distinguish them from the "lettres patentes" sealed by the great seal. Lettres de cachet were rarely employed to deprive men of their personal liberty before the 17th century. They were previously made use of occasionally as a means of delaying the course of justice; but during the reign of Louis XIV. they were obtained by any person who had sufficient influence with the king or his ministers, and persons were imprisoned for life, or for a long period, on the most frivolous pretexts, for the gratification of private pique or revenge. The terms of a lettre de cachet were as follows:—"M. le Marquis de Launay, je vous fais cette lettre pour vous dire de recevoir dans mon château de la Bastille le Sieur ———, et de l'y retenir jusqu'à nouvel ordre de ma part. Sur ce, je prie Dieu qu'il vous ait, M. le Marquis de Launay, en sa sainte garde." These letters, giving power over personal liberty, were openly sold in the reign of Louis XV. by the mistress of one of the ministers. The lettres de cachet were also granted by the king for the purpose of shielding his favourites or their friends from the consequences of their crimes; and were thus as pernicious in their operation as the protection afforded by the Church to criminals in a former age. Their necessity was strongly maintained by the great families, as they were by them enabled to remove such of their connexions as had acted in a manner which was thought to bring discredit on the family. During the contentions of the Mirabeau family, fifty-nine lettres de cachet were issued on the demand of one or other of its members. The independent members of the parliaments and of the magistracy were proscribed and punished by means of these warrants. This monstrous evil was swept away at the Revolution, after Louis XVI. had in vain endeavoured to remedy it.

CACHOUTANNIC ACID. [Tannic Acids.]

CACIQUE, a Mexican word which signifies "lord" or "master." It was generally adopted by Spanish writers to signify the chiefs, governors, or principal personages of those American tribes with whom the Spaniards became acquainted by their conquests in the New World. (Prescott, 'Conquest of Mexico;' and 'Conquest of Peru.'

CACODYL ($C_4H_6As=Kd$), an excessively poisonous organo-metallic body, containing arsenic. It is best prepared from its chloride in the following manner: Digest slips of zinc in chloride of cacodyl for three hours, in a glass bulb blown upon a glass tube previously filled with carbonic acid gas. The zinc dissolves without the evolution of any gas; when the residual white saline mass is treated with water, the chloride of zinc dissolves, and a heavy oily liquid separates, which is cacodyl, and is rendered pure by cautious distillation from a fresh portion of zinc.

Its properties are: It is a thin, transparent, colourless liquid, much resembling arseniuretted hydrogen in odour, and is so very

inflammable, that when poured into oxygen, chlorine, or the air, it takes fire; it boils at 338°; when cooled to 21° it crystallises in large transparent square prisms. It is heavier than water, and being nearly insoluble in it, sinks when added to it. Alcohol and ether dissolve it. Its formula is C_4H_6As = Kd.

Oxide of Cacodyl.—Equal parts of arsenious acid and acetate of potash are to be accurately mixed and put into a glass or iron retort, to which a cooled receiver is adapted, with an apparatus to carry off the incondensible gaseous product, which is chiefly carbonic acid and hydride of methyl. When the heat has been long continued, some metallic arsenic and two liquids are found in the receiver: the lighter consists mostly of water, with acetic acid and acetone; and the heavier is impure oxide of cacodyl, or alcarsin, formerly called the *liquor of Cadet*.

The product is obtained in a pure state by repeated washing with water free from air, and redistillation from hydrate of potash in a retort containing hydrogen gas; this operation, on account of the poisonous nature of alcarsin, must be conducted with great care and special arrangements made for conveying away the fumes from the neighbourhood of the experimenter.

The properties of this substance are: It is a colourless liquid; its density is 1·462; its smell is extremely disagreeable, and the vapour affects the eyes and nose. Water dissolves little of it, but alcohol takes it up readily; it boils at about 248°, and solidifies, becoming a white crystalline mass, at 9°. By exposure to the air a dense white smoke is emitted, the alcarsin becomes hot, and afterwards burns spontaneously with a pale flame, producing arsenious acid, carbonic acid, and water. It is composed of 4 equivalents of carbon = 24, 6 equivalents of hydrogen = 6, 1 equivalent of arsenic = 75, 1 equivalent of oxygen = 8. Its formula is C_4H_6AsO = KdO.

Chloride of Cacodyl.—Mix a dilute alcoholic solution of oxide of cacodyl with one of corrosive sublimate, avoiding an excess of the latter; by their mutual action a colourless inodorous crystalline precipitate is obtained (C_4H_6AsO, HgCl); and when this is distilled with hydrochloric acid, there are formed water, chloride of mercury, and chloride of cacodyl, the latter coming over; this is subjected to the action of lime and chloride of calcium, and then distilled in a retort containing carbonic acid gas. The chloride of cacodyl thus produced is a colourless liquid; its odour is more disagreeable and its vapour more poisonous than that of the oxide of cacodyl; it does not fume when exposed to the air, but its vapour, which is colourless, is spontaneously inflammable in it. It is heavier than and insoluble in water; alcohol combines with it readily, but ether does not; its boiling-point is a little above 212°. Its formula is KdCl.

Iodide of Cacodyl (C_4H_6AsBr), and *Bromide of Cacodyl* (C_4H_6AsI), may be formed by treating the above hydrargyro-oxychloride of cacodyl with hydriodic, or with hydrobromic acid.

Cyanide of Cacodyl (C_4H_6As, NC_2 = KdCy) may be obtained by distilling oxide of cacodyl with hydrocyanic acid, or a strong solution of cyanide of mercury. The product crystallises in brilliant prisms. Fusing point 91°, boiling point 284. Vapour density 4·63. This compound is even more deadly poisonous than the other compounds of cacodyl. A single grain diffused in vapour through the atmosphere of an ordinary apartment causes numbness of the hands and feet, giddiness, a buzzing noise in the ears and sometimes fainting; but usually these symptoms are of short duration after the poisoned air has been removed.

Sulphide of Cacodyl (C_4H_6As, S = KdS) is best obtained by distilling a mixture of sulphide of barium and chloride of cacodyl. It is a colourless transparent liquid, of an exceeding penetrating fetid odour. Its boiling point is 212°. It does not solidify at a temperature of −40°, Vapour density 7·72. It is insoluble in water, but miscible in all proportions with alcohol and ether.

Sulphocacodylic Acid ($C_4H_6AsS_3$), or tersulphide of cacodyl, is obtained in combination by precipitating metallic salts with sulphocacodylate of cacodyl, or bisulphide of cacodyl, a compound obtained by acting upon cacodylic acid with sulphuretted hydrogen.

Cacodylic Acid ($C_4H_6AsO_3$ = KdO_3). *Alcargen.*—When cacodyl or its oxide is left under water to the slow action of the air, they oxidise and become cacodylic acid; or it may be prepared by adding oxide of mercury to oxide of cacodyl, covered with a layer of water, and artificially cooled until the mixture loses all odour; any cacodylate of mercury which may have been formed is to be decomposed by the cautious addition of more oxide of cacodyl; by evaporation to dryness and solution in alcohol crystals of cacodylic acid are obtained, which have the following properties: They are colourless, brittle, brilliant, prismatic crystals; permanent in a dry atmosphere, but deliquescent in a moist one. Cacodylic acid is insoluble in ether, but dissolved by alcohol, and the solution has an acid reaction; it yields by combination with the alkalies and evaporation, a gummy mass; it forms crystalline compounds with the oxides of silver, mercury, &c.

From experiments tried on animals, it would seem, that cacodylic acid possesses little or no poisonous quality. This is somewhat remarkable, especially when we bear in mind that it contains more than half its weight of arsenic.

Cacodyl combines with various other bodies, yielding compounds which have been particularly described by Bunsen, and of which an account may be seen in a series of papers published by that eminent chemist in Liebig's 'Annalen,' vols. xxxvii. xlii. xlvi. [Organo-metallic Bodies.]

CACODYLATES. [Cacodyl.]

CACODYLIC ACID. [Cacodyl.]

CACOPLATYL (C_4H_4PtAs). This body may be represented as cacodyl in which two equivalents of hydrogen are replaced by one of diatomic platinum. When a mixture of solutions of chloride of cacodyl and bichloride of platinum are heated and allowed to cool, crystals of chloride of cacoplatyl separate out, the reaction is expressed in the following equation:—

$$\underbrace{C_4H_6As, Cl}_{\text{Chloride of cacodyl.}} + PtCl_2 = 2HCl + \underbrace{C_4(H_4Pt)\,As, Cl}_{\text{Chloride of cacoplatyl.}}$$

Chloride of Cacoplatyl crystallises in beautiful needles. It is inodorous, and has a nauseous arsenical taste, is soluble in hot water and hot alcohol, and when heated darkens in colour, takes fire, and smoulders away, giving off arsenical fumes and leaving a fusible residue of arsenide of platinum. Sulphuric acid colours it yellow. It is very soluble in ammonia, and the solution yields on evaporation a crystalline body insoluble in alcohol.

The *Bromide of Cacoplatyl* (C_4H_4 PtAs, Br.) and the *iodide of cacoplatyl* (C_4H_4 PtAs, I) are obtained by decomposing chloride of cacoplatyl with bromide or iodide of potassium. They are both beautifully crystalline, soluble in hot water, and have a disagreeable arsenical taste. They each contain two equivalents of water of crystallisation.

The *Sulphate of Cacoplatyl* is obtained by boiling chloride of cacoplatyl with a solution of sulphate of silver. It has the form of white crystalline grains, is very stable, without odour, and of a bitter and astringent taste. [Organo-metallic Bodies.]

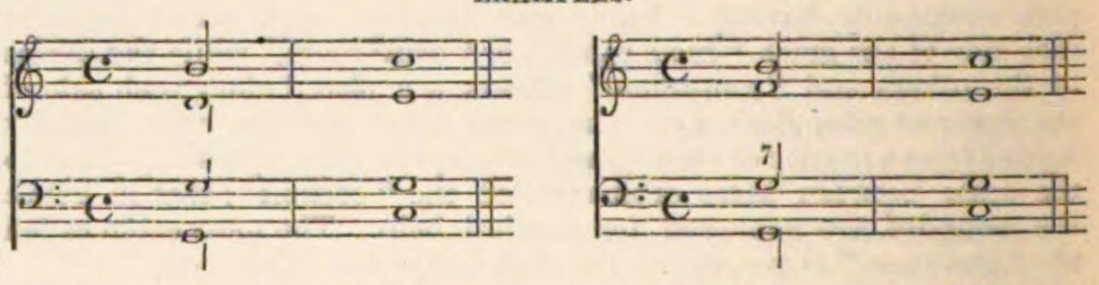
CACOTHELINE. [Nux Vomica, Alkaloids of.]

CACTIN. When the flowers of the *Cactus speciosus* are extracted with alcohol they yield a carmine red colour, to which the name of cactin has been given. Its composition and properties are not known.

CADENCE, in Music (*cadenza*, Ital., *cadence*, Fr., from *cado*, Lat., *to fall*), the close of a musical passage or phrase, or the resolution of a dissonant chord into a consonant one.

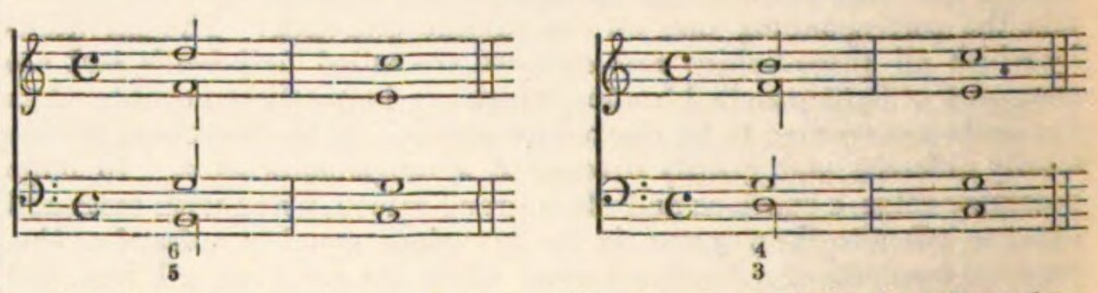
Cadences, which are in some degree analogous to punctuation in grammar, are resting places for the mind, serving to divide a composition into several parts, or to separate the different members of a musical sentence. They are either perfect or imperfect. The perfect cadence is composed of the chord of the dominant, followed by that of the tonic; likewise of the chord of the dominant seventh, succeeded by that of the tonic.

EXAMPLES.

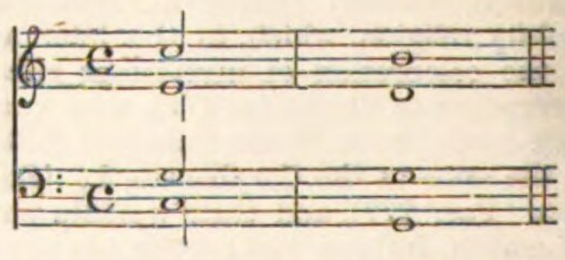


The first and second inversions of the dominant seventh, followed by the chord of the tonic, also form perfect cadences, but are rarely used as final cadences.

EXAMPLES.

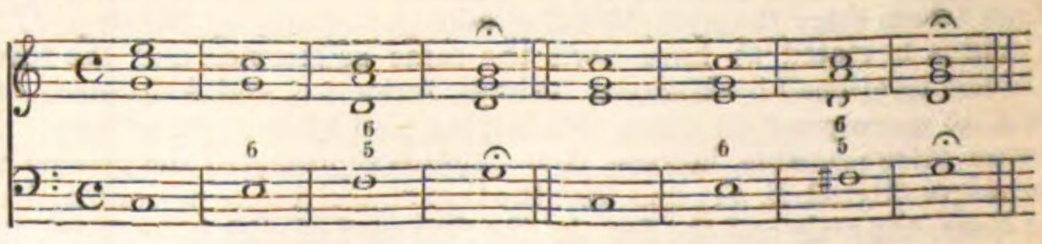


The imperfect cadence consists of the chord of the tonic, followed by that of the dominant, but is never met with as a final close, except in some very few old ecclesiastical compositions.



Albrechtsberger gives the subjoined formulæ of this cadence.

No. 1. No. 2.

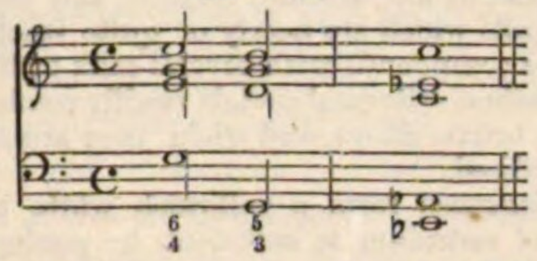


But in No. 2, the introduction of the F sharp changes the key

G therefore is no longer the dominant, but becomes the tonic; consequently a composition thus ending terminates irregularly, and not with an imperfect cadence, if the accepted definition of the latter be correct.

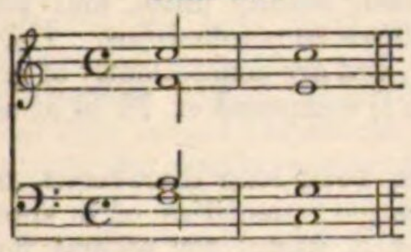
Besides the perfect and imperfect cadences, many writers speak of the *interrupted* or *deceptive* cadence. It is formed by a chord quite foreign to that which was expected, thus evading the close, and deceiving expectation.

EXAMPLE.



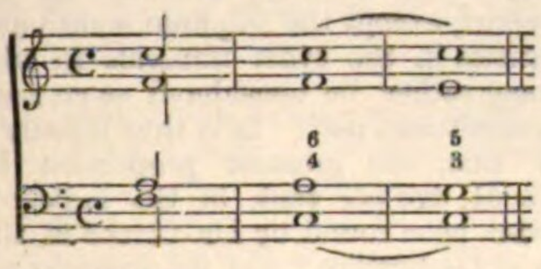
There is also another kind of cadence, to which the name of *plagal* is given; and this is sometimes classed as an imperfect cadence. It consists of the chord of the subdominant, followed by that of the tonic, and is occasionally used in church and other sacred music.

EXAMPLE.



Sometimes in this cadence the chord of the subdominant is suspended on part of the final tonic.

EXAMPLE.



The term *cadence* is also used to signify the addition made by the performer at the close of an air or concerto, and supposed to be an extemporaneous effusion, for the purpose of displaying such taste, skill, and power as the composition itself affords no means of exhibiting. The *cadenza*, however, if introduced at all, should always be in good keeping with the air, &c., to which it is appended; it ought to preserve the same general character, and should invariably be brief, in the instance of vocal music especially. Formerly the *cadenza* was, by Italian as well as English singers, considered indispensable, and many were the incongruous flights of ill-regulated fancy that audiences had to endure. The French never admitted it; the Italians have now wisely discarded it; and the English have also begun to abandon it.

The *cadenza* is so called, says Rousseau, because introduced generally on the first note of the final cadence.

CADET, LIQUOR OF. [Cacodyl.]

CADI, according to Mr. Lane ('Arabian Nights,' vol. i.), *Kâdee*, is a judge or minister of justice, who passes sentence in all cases of law: religious, moral, civil, and criminal. This he generally does, in the present day, in accordance with the decision of a Mufti, or doctor of the law. In small towns and villages he is often employed to draw up written contracts of various kinds. The Persian pronunciation of the word is *Câzi*, sometimes written *Kazee* or *Kauzee*. In the Mohammedan states in India the câdi continues to be the chief judge; but in Turkey he is subject to the Mufti, and in Persia he stands under the Sheikh-ul-Islâm or supreme judge (literally "the elder or chief of the faith"), in all the principal cities where an officer of that rank resides; and the latter functionary has in general the further gratuitous aid of the council of Mullâs (Moollahs) or learned men.

The law of all Mohammedan nations, which is administered by the câdis, is founded partly on the Koran, and partly on the Sunnah or tradition; but in Persia, since the establishment of the faith of the Shiites as the national religion of the country, jurists have rejected all traditions coming from the three first caliphs, Abu Bekr, Omar, and Osman, or from other persons who opposed the right of Ali to the succession of Mohammed.

CA'DMIUM (Cd), *Klaprothium*, *Melinum*, a peculiar metal, discovered in 1818; it was found in some ores of zinc, and especially in the Silesian. On account of the effect which was produced by the action of sulphuretted hydrogen upon some preparations of zinc, the presence of arsenic was suspected, but the appearance was found to be owing to this new metal. The first notice of its existence was by Hermann, but Stromeyer more particularly examined and detailed its properties, and gave it the name of *cadmium*, from *cadmia*, *fossilis*, *calamine*, or καδμεια, a name by which the common ore of zinc was formerly known.

In order to separate cadmium from the mineral containing it, it is

to be dissolved in sulphuric acid, and the solution, which should have excess of acid, is to be diluted with water, and to have a current of sulphuretted hydrogen gas passed into it, until a yellow precipitate ceases to be formed. This precipitate is sulphuret of cadmium, which is to be dissolved in concentrated hydrochloric acid, and the excess of acid being expelled by evaporation, the residual salt is to be dissolved in water, and precipitated by carbonate of ammonia, an excess of which dissolves any oxide of zinc or copper that may have been thrown down by the sulphuretted hydrogen with the sulphuret of cadmium. The carbonate of cadmium thus obtained is to be heated to redness, to expel carbonic acid, then mixed with lamp black, and heated to dull redness in a glass or porcelain retort: it is thus reduced, and the metal distilled. The impure Silesian oxide of zinc is stated to contain from 1½ to 11 per cent. of this metal.

Cadmium has the colour of tin, is brilliant, and susceptible of a fine polish. Its fracture is fibrous, and it crystallises readily in regular octohedrons; while solidifying, its surface is covered with arborations like fern leaves. It is soft, easily bent, filed, and cut; it stains substances upon which it is rubbed, like lead. When bent it gives a peculiar crackling noise, like tin. It is very ductile, easily drawn into wire and beaten into thin leaves. Its specific gravity after fusion is 8·604, but when beaten 8·694. Cadmium melts below a red heat; and at a temperature a little below that of boiling mercury, it boils and distils in drops. The vapour of cadmium has no particular odour. Like tin it is slowly acted upon by the air, but is eventually tarnished by it.

Oxygen and Cadmium readily unite to form an oxide. It may be procured either by burning the metal, by decomposing a solution of the metal with an alkali and washing and calcining the precipitate, or by igniting the carbonate or nitrate. The colour of oxide of cadmium depends upon its state of aggregation; it is either deep reddish yellow, bright brown, deep brown, or even black. It is neither fusible nor volatile, even at a very high temperature. Oxide of cadmium is insoluble in water, but is precipitated in the state of hydrate by solution of potash; this hydrate is white, insoluble in the fixed alkalies, but soluble in ammonia. Carbonate of ammonia, however, does not dissolve it, and this difference between it and oxide of zinc serves as a process for separating them. Oxide of cadmium is composed of—

1	Equivalent of	oxygen	= 8
1	„ „	cadmium	= 56·74
	Equivalent of	oxide	64·74

Suboxide of Cadmium (Cd_2O), containing two equivalents of metal to one of oxygen, is obtained when oxalate of cadmium is heated in a retort to the melting-point of lead. It is a green powder.

Nitrogen and cadmium form, according to Mr. Grove, a spongy, dark, lead-gray substance, Its specific gravity is 4·8.

No compound of hydrogen and cadmium is known.

Chlorine and Cadmium combine to form only one chloride; this compound may be obtained by dissolving either the metal or its oxide in hydrochloric acid. The solution, by spontaneous evaporation, is gradually converted into a mass of short satiny crystals, composed of—

1	Equivalent of	chlorine	= 35·5
1	„ „	cadmium	= 56·74
2	„ „	water	= 18
			110·24

These crystals are readily soluble in water, and effloresce in warm dry air. The effloresced salt fuses below a red heat, and on cooling it assumes the appearance of a transparent, lamellated, crystalline mass, which has a faint, pearly, metallic lustre. By exposure to the air it acquires water, and falls to powder.

No compound of carbon and cadmium is known.

Sulphur and Cadmium unite to form only one sulphide, which consists of—

1	Equivalent of	sulphur	= 16·00
1	„	cadmium	= 56·74
	Equivalent of	sulphide	72·74

This metal does not readily unite with sulphur when they are heated together. The compound is more easily formed when the oxide is heated with it, but the best method is to precipitate a salt of cadmium with sulphuretted hydrogen. In this state it forms a pigment known as *jaune brilliant*. It has a yellow colour, inclining to orange. It was this colour which first led to the suspicion that zinc contained arsenic. When heated to redness it becomes brown, and afterwards carmine red, but on cooling it resumes its original colour. It is not decomposed at a high temperature; but a strong white heat melts it, and causes it to crystallise on cooling in transparent plates of a fine yellow colour. Concentrated hydrochloric acid decomposes it with the evolution of sulphuretted hydrogen, and without any deposit of sulphur. Nitric acid converts it into sulphate of cadmium. Sulphide of cadmium is insoluble in sulphide of ammonium; this serves to distinguish it from sulphide of arsenic, which is soluble in that reagent.

Sulphide of cadmium is also found native in the form of *Greenockite*.

Phosphorus and Cadmium combine readily; the resulting phosphide

is gray, has a weak metallic lustre, is brittle, and but slightly fusible. When heated in open vessels it burns with a very bright phosphoric flame, and is converted into phosphate of cadmium. It dissolves in hydrochloric acid with the evolution of phosphuretted hydrogen gas.

Iodine and Cadmium may be made to combine by treating the metal with iodine, either in the moist or dry way. Iodide of cadmium forms large hexagonal tubular crystals, which are colourless and transparent, have a shining pearly lustre, and do not alter by exposure to the air. This salt is readily soluble both in water and in alcohol. The crystals fuse readily, losing their water of crystallisation, and again crystallising. At a higher temperature this salt is decomposed, iodine vapourising, and metallic cadmium being left. It is composed of—

1 Equivalent of iodine	=	126·80
1 „ „ cadmium	=	56·74
Equivalent	=	183·54

Iodide of cadmium as an external remedial agent is said to be superior to all other iodides used for that purpose. It is not decomposed by air or light, and hence preference is given to it in the preparation of iodised collodion for photographic experiments.

Bromine and Cadmium combine at a red heat, forming bromide of cadmium. It readily fuses, and at a high temperature sublimes in white pearly laminæ. It is soluble in water, and on evaporation is obtained in white needles containing—

1 Equivalent of cadmium	=	56·74
1 „ „ bromine	=	80·00
1 „ „ water	=	36·00
Equivalent		172·74

Fluorine and Cadmium form a fluoride which is but little soluble in water, but more so when acid is in excess. On evaporating the solution an irregular crust is deposited, which adheres to the vessel. It is composed of—

1 Equivalent of fluorine	=	19·00
1 „ „ cadmium	=	56·74
Equivalent	=	75·74

The various oxy-acids combine with oxide of cadmium to form salts, the general properties of which are, that a considerable number of them are soluble in water, and the solutions are in general nearly or quite colourless: the insoluble salts are also commonly devoid of colour. The soluble salts are decomposed by ammonia and the fixed alkalies, they throwing down white hydrate of cadmium, which an excess of ammonia re-dissolves. The alkaline carbonates precipitate white carbonate of cadmium; sulphuretted hydrogen occasions a yellow deposit; ferrocyanide of potassium, a white one; and infusion of galls produces no effect. A plate of zinc throws down metallic cadmium.

The cadmium salts have a disagreeable metallic taste, and are powerfully emetic.

Nitrate of Cadmium crystallises in radiating needles, which attract moisture from the air, and are very soluble in water and alcohol. This salt consists of—

1 Equivalent of nitric acid	=	54·00
1 „ „ oxide of cadmium	=	64·74
4 „ „ water	=	36·00
Equivalent	=	154·74

Carbonate of Cadmium is readily obtained by adding a solution of carbonate of soda to one of nitrate of cadmium. It is a white insipid powder which is insoluble in water. When heated it is decomposed, owing to the expulsion of the carbonic acid. It is constituted of—

1 Equivalent of carbonic acid	=	22·00
1 „ „ oxide of cadmium	=	64·74
Equivalent	=	86·74

Sulphate of Cadmium crystallises in large transparent prisms, much resembling sulphate of zinc in appearance. This salt readily dissolves in water. It effloresces when exposed to the air, and at a low heat loses its water of crystallisation without fusing. The dry salt is not easily decomposed, a low red heat not being sufficient to expel the sulphuric acid; but at a higher temperature it loses part of its sulphuric acid, and becomes a subsulphate. Its constituents are—

1 Equivalent of sulphuric acid	=	40·00
1 „ „ oxide of cadmium	=	64·74
4 „ „ water	=	36·00
Equivalent	=	140·74

Acetate of Cadmium crystallises in fine needles, which are readily soluble in water, and do not alter in the air; they are composed of—

1 Equivalent of acetic acid	=	51·00
1 „ „ oxide of cadmium	=	64·74
2 „ „ water	=	18·00
Equivalent	=	133·74

These are the most important crystallisable salts of cadmium; with phosphoric, boracic, oxalic, arsenic, tartaric, and citric acids, oxide of cadmium forms salts which are nearly or quite insoluble in water. It forms also double compounds with several salts of the alkalies.

Alloys of Cadmium.—Several metals readily combine with cadmium, and form with it brittle alloys, and when they are strongly heated the cadmium is volatilised.

Copper and Cadmium form a yellowish white brittle alloy, and a small quantity of cadmium is sufficient to produce this effect; 100 parts of copper retain 82·2 of cadmium when exposed to a red heat, but when the alloy is heated to the fusing point of copper, the cadmium is volatilised entirely.

Platinum and Cadmium yield an alloy which is of a silver white colour, brittle, and not readily fusible; 100 parts of platinum retain 117·3 of cadmium at a red heat.

Mercury and Cadmium readily unite, and form a fine argentine amalgam, which crystallises in octohedrons. The crystals fall to the bottom of the mercury, and are consequently of greater specific gravity. The saturated amalgam is composed of 78·26 of mercury, and 21·74 of cadmium.

Cadmium not having been long discovered, no very great use has been made of it. If larger quantities of it should be obtained, its malleability may render it useful for several purposes. Sulphate of cadmium has been used in medicine as a substitute for that of zinc in collyria, but whether with any advantage over it has not been determined.

CA'DMIUM, ORES OF. Properly speaking, no ore of this metal has yet been discovered, except the sulphide mentioned; for it occurs in such small quantities in the other minerals in which it has been detected, that it may rather be considered as an accidental impurity than an essential constituent part. It is thus usually found associated with the ores of zinc, the greatest proportion being found by Stromeyer to be about five per cent. in the radiated zinc-blendes of Bohemia. It has also been found by Dr. Clarke in the oxides of zinc, both of Freiburg and Derbyshire; and its presence may also be generally detected in the common zinc of commerce, and may usually be obtained in considerable quantity mixed with the soot from the crucibles in which the oxides of zinc are reduced by being heated with coal. Portions of this substance from the zinc works of Bristol were found to contain from 12 to 20 per cent. of cadmium.

CADU'CEUS, a staff of laurel or olive, with a representation of two snakes twisted about it. The caduceus was a symbol of Hermes or Mercury, to whom, according to the fable, it was given by Apollo, in return for the lyre which Mercury had presented to him. It was also the badge of the heralds of ancient Greece; and the name, which is also written Caduceum, is apparently only a corruption of the Greek κηρύκειον (kerykeion), herald's staff. In its oldest form it was merely a bough, like the Greek ἱκετήριον (hiketérion), and the Roman *supplicia*, twined about with white wool. Afterwards a white or gilded staff, with imitations of foliage and ribands, was substituted for the old rude symbol. These were probably not turned into snakes till a much later age, when that reptile had acquired a mystic character. Many explanations of the caduceus have been attempted by modern scholars; that of Böttiger is plausible, who supposes that it was a representation of a peculiar knot (the *nodus Herculis*, Macrob. I., Saturn. c. 19) used by the Phœnicians in cording up their packages, and thence adopted by them as a means of signifying to the inhabitants of the countries on which they landed, their wish to be upon a friendly footing with them; and as the Phœnicians were, generally speaking, the first strangers with whom any people of Greece had intercourse, their symbol of amity would probably be used for the same purpose, whenever an occasion offered. (Böttinger, 'Vasengemälde,' part ii. p. 97; 'Amalthea,' vol. i. p. 116); but the most probable, as it is the most simple, is that of Müller, who says that it was originally the olive-branch with the στέμματα, which later became developed into serpents. ('Archäologie der Kunst,' § 379.)

CÆLUM SCALPTO'RIS, the sculptor's tool, a constellation of Lacaille. It is situated below Columba Noachi and Canis Major, low enough not to rise in this country. The following are the principal stars in this constellation:—

Character.	No. in Catalogue of Piazzi.	No. in Catalogue of British Association.	Magnitude.
δ	129	1413	4
α	175	1458	4
β	181	1464	4
γ	308	1573	4

CÆSU'RA, or its Greek equivalent τομή (that is, *cutting*, the two words being respectively derived from the stems *caed* and *tem*, cut), is

the name given by ancient grammarians to the division of a verse into two or more portions by a pause or pauses, the position of which must be consistent both with the rhythm of the metre and the meaning of the words. If in any metre the termination of every foot coincide with the termination of a word, a painful monotony arises which would soon offend the ear; as in the lines,—

Sparsis hastis longis campus splendet et horret.—*Enn.*
Disperge hostis, distrahe, diduc, divide, differ.—*Enn.*
Has res ad te scriptas Luci misimus Aeli.—*Lucil.*

This has led some grammarians to hold the opinion that the several feet of a verse should be blended together; yet this principle might lead to results no less offensive than the lines that have been just quoted, as may be seen in the following verses :—

Sole cadente juvencus aratra reliquit in arvo.

Πολλα δ' αναντα καταντα παραντα τε δοχμια τ' ηλθον.

Much that has been written about the cæsura betrays an inaccuracy which has arisen from a neglect of the principle of accent. Those who define verses by the mere order of the long and short syllables find it necessary afterwards to lay down what appear to be arbitrary canons. Thus a word of three long syllables, such as *prorumpunt*, might, according to the usual definition of an hexameter verse, occupy any place which did not interfere with the two short syllables of the fifth foot. Yet an ear acquainted with the true rhythm of this verse would be violently offended by any line beginning with *Et prorumpunt*, or *Continuo prorumpunt*, or *Continuo nostri jam prorumpunt ululantes*. The true objection to these lines is that the accent of the word *prorumpunt*, which of course falls upon the penult, is inconsistent with the demands of the verse, which, in the positions here given to the word, would compel us to falsify the accent, and pronounce *prórumpúnt*. [Hexameter.] A part of these difficulties they evade by adding to the previous definition of the hexameter a canon to the effect that there must always be a cæsura at the end of two feet and a-half, or three feet and a-half, with the additional proviso that the syllable immediately preceding the cæsura must not be a monosyllable. To this canon there are two serious objections besides its arbitrary character: one that it does not exclude *prorumpunt* from its position in the third example; the other that it lays down a rule which is violated in many of the finest verses of the Æneid. The same neglect of accents has led to precisely the same difficulties in the other metres.

The name of cæsura or τομη (or κόμμα, which has the same meaning) is sometimes given to that portion of a verse which precedes the pause. Thus when the pause occurs at the end of the fourth foot of the hexameter, that fourth foot being a dactyl, which is common in the bucolic writers, the four first feet so cut off bear the name of a bucolic cæsura.

CAFFEIC ACID. [Tannic Acids.]

CAFFEINE, *Thèine*, *Guaranine* ($C_{16}H_{10}N_4O_4 + 2\,Aq.$). A crystalline alkaloid found in coffee, tea, and two other vegetable preparations, namely, in guarana, a paste prepared from the seeds and other parts of the *Paullinia sorbilis*, and in the leaves of *Ilex Paraguayensis*, both of which are used in the production of beverages in the Brazils and a few other parts of the world. Caffeine was first discovered in coffee by Runge in 1820, and a few years afterwards in tea by Oudry, who called it thèine: the identity of the two substances has since, however, been fully established.

It exists, according to Payen and other chemists, in combination with potash and chlorogenic, caffeic, or caffetannic acid, and is best prepared as follows: A decoction of tea or coffee is mixed with excess of solution of basic acetate of lead and filtered; through the clear liquid is passed a current of sulphuretted hydrogen, the sulphide of lead separated by filtration, and the filtrate evaporated to a small bulk. On cooling the caffeine crystallises out nearly pure, and may be rendered quite white by boiling in water or ether with a little powdered animal charcoal, filtering and recrystallising.

So obtained, it presents the appearance of long silky needles. They contain 8·4 per cent. of water, which is not thoroughly separated below a temperature of 302°. At 352° they melt, and at a higher heat sublime without decomposition. It is readily soluble in ether; also in boiling alcohol or boiling water, but from these it nearly all crystallises out on cooling. Heated with strong alkalies it is decomposed with production of methylamine. Hydrochloric acid dissolves it, but on evaporation it is deposited unchanged. Caffeine, nevertheless, does possess basic properties, and, by carefully avoiding the presence of water, several well-defined salts may be obtained. The most remarkable and beautiful of these are the double chlorides with platinum, gold, and mercury.

Caffeine is powerfully attacked by oxidising agents, giving rise to several bodies of considerable interest, inasmuch as they establish its intimate connection with the uric group of the formic series of organic compounds. These are: 1st, amalic acid, obtained by Rochleder on passing a current of chlorine through caffeine suspended in water, stopping the gas before the caffeine is all dissolved, filtering and evaporating the filtrate; 2nd, Cholestophane (the nitro-thèine of Stenhouse); obtained by the *prolonged* action of chlorine or nitric acid; and 3rd, Murexoin, obtained by the action of ammonia on amalic acid. These bodies are homologous with alloxantine, parabanic acid, and murexid (compounds obtained by similar processes from uric acid), and differing only from these latter by having equivalents of the radical methyl (C_2H_3) in the place of an equal number of equivalents of hydrogen. The following diagram will show this at a glance :—

Alloxantin . .	$C_{16}H_4N_4O_{14}$	Parabanic acid .	$C_6H_2N_2O_6$
Dimethyl-alloxantin, or amalic acid . .	$C_{16}(C_2H_3)_4N_4O_{14}$	Dimethyl-parabc. acid, or Cholestrophane .	$C_6(C_2H_3)_2N_2O_6$
Murexid	$C_{16}H_8N_6O_{12}$		
Dimethyl-murexid	$C_{16}H_4(C_2H_3)_4N_6O_{12}$		
Caffeo-murexid, or murexoin .			

The use of caffeine as an article of diet has not yet been satisfactorily ascertained. That this is a question of no mean interest is obvious when we consider that it exists in four substances differing widely from each other in their botanical origin, and yet all instinctively used for the same purpose by the various nations of the world, namely, the production of useful and agreeable beverages. Liebig suggests that it contributes to the formation of taurine, a compound peculiar to bile. He considers bile to be one of the products of the decomposition of animal tissues, and has lately found caffeine in muscular flesh. Lehman has found that its administration is always followed by a slight augmentation of the secretion of urea.

CAFFEO-MUREXID. [Caffeine.]

CAFFETANNIC ACID. [Tannic Acids.]

CAFFILA is the term used in Northern Africa for those companies of travelling merchants which in Asia are called caravans. The order in which they are arranged is the same, but the caffilas being generally less numerous than the caravans, this order is not so strictly observed.

CAIMACA'N, more properly *Kaimakam*, a Turkish name which corresponds to our lieutenant, or rather lieutenant-governor. The caimacan of Constantinople is the lieutenant of the grand vizir, whom he represents in processions when absent. It is an office of importance, and the person who fills it is generally styled pasha. (La Croix, 'Mémoires sur l'Empire Ottoman.') The pashas or governors of provinces have also their caimacans or lieutenants, who often act as governors of the principal towns.

CAÏNCIC ACID ($C_{32}H_{26}O_{14}$?). This acid is obtained from the root of the *Chiococca anguifuga*, a plant employed in the Brazils as an antidote for the bite of serpents. It is also contained in the root of the *Chiococca racemosa*. The acid is extracted by digesting the powdered root in alcohol, concentrating the alcoholic extract, then adding water and filtering. The filtered liquor is treated with milk of lime, by which an insoluble sub-caïncate of lime is produced. This salt is then to be decomposed by a hot alcoholic solution of oxalic acid; when, after filtration and cooling, the caïncic acid is deposited in the form of small needles.

Caïncic acid is inodorous, bitter to the taste, reddens litmus, dissolves in 600 parts of water, but is much more soluble in alcohol. Acids and alkalies transform it into *quinovatic acid* and grape sugar. Taken internally, caïncic acid acts as a powerful diuretic.

CAIRN, a heap of stones piled over the remains of the dead. Lhuyd, in his 'Additions to Camden's Britannia in Radnorshire, asserts that in the Cambro-Britannic *Kaern* is a primitive word, appropriated to signify such heaps of stones. Cairns and tumuli of earth were the common monuments which the ancient Britons, like the Northern races generally, erected in honour of their great men, as indeed they appear to have been of the most aboriginal races. [Tumulus.] Which of the two kinds was to be adopted was probably determined by the circumstance of the country being stony or otherwise.

Pennant, in his 'Voyage to the Hebrides,' 1772 (4to. Lond. 1790, vol. ii. p. 208), speaking of the cairns, says, "These immense accumulations of stones are the sepulchral protections of the heroes among the ancient natives of our islands: the stone chests, the repositories of the urns and ashes, are lodged in the earth beneath; sometimes one, sometimes more, are found thus deposited; and I have one instance of as many as seventeen of these stone chests being discovered under the same *cairn*. The learned have assigned other causes for these heaps of stones; have supposed them to have been, in times of inauguration, the places where the chieftain-elect stood to show himself to the best advantage to the people; or the place from whence judgment was pronounced; or to have been erected on the road-side in honour of Mercury; or to have been formed in memory of some solemn compact.' (See Rowland's 'Mona Antiqua,' p. 50; Borlase's 'Antiq. of Cornwall,' p. 209.) These opinions were once very prevalent, but it is now generally said that the cairn was simply monumental.

"These piles," Pennant adds, "may be justly supposed to have been proportioned in size to the rank of the person, or to his popularity: the people of a whole district assembled to show their respect to the deceased, and by an active honouring of his memory soon accumulated heaps equal to those that astonish us at this time. But these honours were not merely those of the day; as long as the memory of the deceased existed, not a passenger went by without adding a stone to the heap: they supposed it would be an honour to the dead, and acceptable to his *manes*. To this moment," he continues, "there is a proverbial expression among the highlanders allusive to the old practice: a suppliant will tell his patron, *Curri mi cloch er do charne* (I will add

a stone to your *cairn*), meaning, when you are no more I will do all possible honour to your memory." Cairns or remains of cairns, are found throughout the British islands; in France, (especially in Brittany); also, but rarely as compared with earthen tumuli, in Germany, Sweden and Denmark, and other parts of Europe.

Jamieson, in his 'Etymological Dictionary,' says, "In Angus, where any person has been murdered, a cairn is erected on the spot." [TUMULUS.]

CAISSON. A water-tight vessel used in hydraulic engineering, for the purpose either of closing the entrance to a dock, or any similar work; or of receiving the foundations of a building, which are subsequently sunk upon a bed formed to receive them, and the caisson itself. In 'Vitruvius de Architectura,' lib. 5, cap. 12, there is a description of the mode of employing a species of caisson, or enclosure, to receive the commencement of works to be erected in deep water, which differs little from that still used by the Italian engineers; but the first instance on record of the use of caissons on a large scale, was in the case of the New Westminster Bridge, executed under the orders of Labeleye, a Swiss engineer, about the year 1740. The next instances of their application were in the case of the bridge of Saumur, about 1757, and in many other important works erected by De Cessart. In England, Smeaton and Semple frequently employed this method of executing the foundations of buildings to be erected in deep water; and the former even adopted it in the case of the Ramsgate harbour. It has, however, been found, practically, that if the substratum upon which a caisson is sunk should be susceptible of being undermined, there is great danger of the superstructure being also carried away; and, at the present day, the use of caissons for foundation purposes is almost exclusively confined to such positions as offer naturally a rocky substratum. Caisson gates are, however, still extensively used in dockworks, especially when the gates are not obliged to be frequently opened; and it is for this reason that they are more commonly to be met with in military than in commercial ports.

The caissons formerly used for foundation purposes were in fact timber frames large enough to receive the whole of the intended base. These frames were brought over the position they were meant subsequently to occupy, and which had been prepared to receive them by dredging, or by the use of the diving-bell; and when the masonry of the proposed structure had been raised to a sufficient height, the frame was pierced and sunk. Evidently in such cases the success of the operation depended upon the equal resistance of the ground to be covered, and upon its subsequent powers of resistance to the undermining action of the currents; conditions which can hardly ever be secured in practice. Moreover, it is almost impossible to secure the perfectly vertical position of the mass to be sunk, and thus the defects of the substrata become exaggerated. When caissons are used upon rocky strata, it is customary to make them open at both ends; and, at the present day, to fill them in entirely with concrete, as was done at Rochester and Saltash.

A species of caisson was suggested by Coulomb, in a very curious treatise 'Sur les moyens d'executer sous l'eau toutes sortes de travaux hydrauliques,' 8vo, Paris, 1779, which has been subsequently adopted and improved, in England and in France, in a manner to be noticed hereafter under FOUNDATIONS.

CAJUPUT OIL. This oil is obtained from the leaves of the *Melaleuca minor*, a tree of the natural order Myrtaceæ. The wood of the tree is white, hence the name cajuput (*kayu-puti, white wood*). It grows in the Molucca isles. The leaves are packed in sacks, allowed to ferment for a short time, and then distilled with water, when the oil is carried over with the steam and floats on the condensed liquid.

Cajuput oil as imported is of a green colour, limpid and transparent. It has an aromatic odour, and a taste somewhat resembling camphor. Its specific gravity is usually 0·92. Boiling point 347° Fahr. It may be purified by redistillation. Its chemical composition is, according to Blanchett, $C_{20}H_{18}O_2$. Cajuput oil is soluble in alcohol, without acid reaction, and when pure is quite colourless. It has been asserted that the colour of the oil is owing to the presence of copper derived from the vessels in which it has been stored: this is not the case; the colour is due to chlorophylle, or a matter closely resembling chlorophylle.

Cajuput oil is a medicinal agent. Internally it acts as a diffusible stimulant and antispasmodic, externally as a sudorific.

CALAMINE. [ZINC, CARBONATE OF.]

CALAMUS. [DRAGON'S BLOOD.]

CALCINATION. This chemical term is derived from *calx*, the Latin for quicklime, which, as well known, is prepared by the action of heat upon limestone: the old chemists, therefore, employed the word calcination to express any supposed analogous change; for example, when certain metals, as tin and zinc, are exposed to heat and air, they were said to be *calcined*, and the product was called a *calx*, as of tin or zinc.

It will be observed, therefore, that different operations were included in this term: first, the expulsion of carbonic acid, as when lime is prepared; secondly, the acquisition of oxygen when the metals are heated, and the results of the action of heat and air upon them were termed *calces:* thus calx of tin is now called oxide of tin.

The term calcination is yet employed to express the separation of the volatile from the more fixed parts of a body: thus bones which are heated till they become black are termed *burnt bones;* but when, by the further operation of heat, they become white, they are called

calcined bones; so also we say calcined flints, calcined clay, sulphate of lime, &c. But what were formerly termed metallic calces or calcined metals are now described as metallic oxides.

CAL'CIUM (Ca), a peculiar metal, of which lime is the well-known oxide. It was first obtained by Davy, in 1808, by the action of voltaic electricity; he made chalk or carbonate of lime into a paste with water, and placing it on a plate of platinum, a cavity was made in the paste to receive a globule of mercury. The mercury was rendered negative and the platinum positive by means of a battery of about 100 double plates. In this way the lime being decomposed, its metal formed an amalgam with the mercury. This amalgam was distilled in glass tubes filled with the vapour of naphtha. In an experiment in which the greater part of the mercury was expelled, the tube broke whilst warm, air entered, the metal, which had the colour and lustre of silver, instantly took fire, and burnt, with an intense white light, into lime.

Calcium has been recently investigated by Dr. Matthiesen, who obtained a considerable quantity of it by the electrolytic decomposition of a fused mixture of the chlorides of calcium and strontium, in the proportion of two equivalents of the former to one of the latter. For details of the operation, see 'Quarterly Journal of the Chemical Society,' vol. viii. p. 28.

The specific gravity of calcium is 1·578. It is of a very light gold colour, is malleable and ductile, and possesses a hardness intermediate between lead and gold. Exposed to the air at ordinary temperatures it soon tarnishes by combining with oxygen, and at a red heat melts, and in a current of air burns with a dazzling white light, at the same time throwing off beautiful scintillations. It also burns brilliantly in an atmosphere of chlorine, bromine, iodine, or sulphur. It rapidly decomposes water, setting free and taking the place of the hydrogen. These properties of calcium have still more recently been confirmed by MM. Liès-Boudart and Jobin, who have obtained it by the action of sodium on iodide of calcium at a red heat in closed iron vessels. They fix its spec. grav. at 1·55. Compounds of calcium with other elements have been long known and extensively employed; the first we shall mention is lime, resulting from the union of

Oxygen and Calcium: these substances combine to form two compounds; namely, lime, or the protoxide of calcium, and the peroxide of calcium. It has just been mentioned that calcium and oxygen unite with great force of affinity, which of course prevents calcium from occurring in nature uncombined with this element. Lime has been known from the remotest antiquity, and is one of the most abundant and universally diffused substances in nature. It is never found pure, but always combined either with other earths, or more generally with acids; for example, with carbonic acid in marble, chalk, limestone, and calcareous spar, and in the shells of fish and eggs of birds; with sulphuric acid it constitutes sulphate of lime, or gypsum; with phosphoric acid it forms the earthy part of animal bone; and with silica and other earths it enters into the composition of many minerals and precious stones.

Lime (CaO) is easily obtained in a pure state: the carbonate or any limestone free from impurity is to be mixed with coal or charcoal and exposed to a strong heat; in this way the carbonic acid is expelled, and the lime, or oxide of calcium, remains: this is, in fact, the common process of lime-burning, and the product is frequently called quick-lime.

Lime is composed of—

1 Equivalent of calcium	=	20
1 „ oxygen	=	8
Equivalent	=	28

The properties of lime are: It is white, opaque, inodorous, and its taste is acrid and alkaline; its specific gravity is 3·15. It is infusible in the strongest furnaces; but small quantities have been fused by the oxy-hydrogen blowpipe. By exposure to the air it attracts moisture and carbonic acid, and falls to powder. Lime has great affinity for water; the compound is solid, and called *hydrate of lime. Lime-water* is a solution of hydrate of lime in water.

Hydrate of Lime (CaO, HO), or, as it is usually called, *slaked lime*, to distinguish it from *quick-lime*, is readily prepared by sprinkling this earth with water; it almost immediately heats, cracks, swells, and becomes powdery. During this operation part of the water is rendered solid and combines with the lime, while another portion is expelled in vapour, light as well as heat being evolved; indeed the degree of heat has been found sufficient to set fire to buildings in which lime has been accidentally exposed to water.

When quick-lime is exposed to the air it gradually absorbs both water and carbonic acid, falls to powder, and in that state is termed *air-slaked* lime.

Lime-water is easily prepared by adding the earth to water, but it is better to employ the hydrate for this purpose; and it is a curious circumstance, first noticed by Dr. Priestley, that cold water dissolves a larger quantity than hot: thus an imperial pint of boiling water dissolves only 6¾ grains of lime, but at near 32° it takes up almost exactly 13¼ grains. When lime-water prepared with cold water is heated to ebullition it deposits crystals of lime; but it does not part with any at common temperatures.

Lime-water has a disagreeable taste, and the alkaline property of

turning vegetable yellows brown and blues green. When it is exposed to the air the lime speedily attracts carbonic acid, and pellicle after pellicle of carbonate of lime being formed, the whole of the lime is eventually precipitated: hence the necessity of keeping this solution out of the contact of air.

Milk of Lime is merely hydrate of lime diffused through water. It is best prepared by slaking quick-lime with hot water, and adding cold water till the required consistence is obtained.

Lime is employed for a vast number of purposes in common life, the arts, and manufactures. Among its most important applications are the making of mortar and other cements, and the amelioration of certain soils; it is extensively used also in soap-making, leather-dressing, dyeing, and for various medicinal purposes.

Peroxide of Calcium (CaO_2) was discovered by Thénard; he procured it by the gradual addition of lime-water to peroxide of hydrogen. Small brilliant scales are soon formed, but if much lime-water be added at once then the peroxide of calcium is pulverulent; it is in the state of hydrate, and decomposes spontaneously, losing its excess of oxygen even when left under water, and also by drying *in vacuo*. Neither nitrogen nor hydrogen combines with calcium.

Chlorine and Calcium form one chloride (CaCl). This compound may be formed by direct action, or by passing chlorine gas over lime heated to redness in an earthen tube, oxygen gas is expelled and chloride of calcium remains. It is however more easily procured by saturating hydrochloric acid with lime or chalk, evaporating the solution to dryness, and exposing the residue to a red heat to expel the whole of the water. In this operation the hydrogen of the hydrochloric acid unites with the oxygen of the oxide of calcium; water is formed and expelled, while the metallic chloride remains.

If after evaporating the solution of chloride of calcium to dryness the residue be heated not higher than about 350°, a white porous chloride is obtained, containing two equivalents of water. In this state it is well adapted for drying gases.

The properties of chloride of calcium (formerly called muriate of lime) are: It is colourless, possesses a crystalline appearance when broken, is inodorous, and has an extremely bitter saline taste. It is very deliquescent, and on account of this property it is frequently employed in chemical researches to separate water from gases in order to render them dry, and also to combine with this fluid and with alcohol in various other cases. It fuses readily by heat. Chloride of calcium, after being heated, shines in the dark, and was formerly called Homberg's phosphorus.

When a concentrated aqueous solution of this salt is suffered to cool, crystals are deposited, which, like the anhydrous chloride, are extremely deliquescent. They consist of—

1 Equivalent of chloride of calcium	=	55·5
6 „ water . . .	=	54·0
Equivalent	=	109·5

These crystals are remarkable for the great degree of cold which they occasion when mixed with snow; but the anhydrous chloride dissolves in water with the extrication of heat. The crystals are soluble in one-fourth their weight of water at 60°. The amount of chloride of calcium present in an aqueous solution is most conveniently determined by the specific gravity of the liquid. Thus:—

Sp. gr.	Per cent.	Sp. gr.	Per cent.
1·45	41·91	1·21	23·93
1·42	40·43	1·18	20·85
1·39	38·31	1·15	17·60
1·36	36·49	1·12	14·42
1·33	34·57	1·09	11·23
1·30	32·35	1·06	7·66
1·27	29·67	1·03	3·95
1·24	26·86		

Bromide of calcium (CaBr) is obtained by dissolving chalk in hydrobromic acid. It is a colourless, bitter, deliquescent substance, which readily dissolves in water, with the evolution of heat. The aqueous solution does not easily yield crystals; they contain much water.

Bromate of lime (CaO, BrO_5) is prepared by saturating bromic acid with lime or its carbonate.

Iodide of calcium (CaI). Best made by decomposing sulphide of calcium with iodine, filtering, evaporating to dryness, and heating out of contact of air. The resulting flaky mass has a pearly lustre. It may be easily powdered.

Iodide of calcium is soluble in water, a hot solution yielding long needles of hydrated salt.

Iodate of lime (CaO, IO_5), a crystalline compound obtained by double decomposition of iodate of potash and chloride of calcium.

Carbon and calcium form no compound.

Sulphur and calcium may be made to unite in three proportions. The sulphide, or proto-sulphide (CaS), is obtained by mixing anhydrous sulphate of lime with one-fifth of its weight of powdered charcoal, and heating the mixture to whiteness for two hours in a covered crucible. It is a reddish-white compound, which is but slightly soluble in water, and suffers but little change even when long kept in it. The aqueous

solution is colourless, and has an alkaline and hepatic taste; when evaporated in vacuo, white crystals of the sulphide are formed. When acted upon by hydrochloric acid, sulphuretted hydrogen gas is evolved. After exposure to light, this sulphide shines in the dark, and has been called Canton's phosphorus.

Bisulphide of calcium (CaS_2) is obtained by boiling, but not to saturation, hydrate of lime and sulphur in a large quantity of water. On cooling, yellow needle-shaped crystals are obtained, which are soluble in 400 times their weight of water at 60°, but more so in boiling water, and contain about 43·5 per cent. of water. When lime and sulphur are boiled together in water, till sulphur ceases to be taken up, *persulphide* or *pentasulphide of calcium* is formed, consisting of

1 Equivalent of calcium	=	20
5 „ sulphur	=	80
Equivalent	=	100

Phosphorus and calcium constitute the phosphide (Ca_2P), and like all the binary compounds of this metal hitherto described, except the oxide, it is entirely an artificial product. It is prepared by heating lime in a crucible, and passing vapour of phosphorus into it:

$$P_7 + 14CaO = 2(2CaO, PO_5) + 5Ca_2P.$$

The mixture of phosphate of lime and phosphide of calcium procured is of a brown-red colour.

This phosphide readily decomposes water, and phosphuretted hydrogen gas is evolved; when dissolved in hydrochloric acid this gas is abundantly procured.

Selenium and calcium may be combined by exposing a mixture of selenium and lime to a heat a little below redness. The resulting impure selenide is a brownish-black substance, which has neither smell nor taste, and is insoluble in water; when heated to redness it loses selenium, and selenide of calcium remains. Crystals of this substance may be formed by preparing a solution of lime in hydroselenic acid and exposing it to the air. It is composed of

1 Equivalent of calcium	=	20·00
1 „ selenium	=	39·62
		59·62

No compound of *boron* and *calcium* is known.

Fluorine and calcium occur largely in nature, in combination, and form *fluoride of calcium* (CaF, Equiv. 39), called by mineralogists fluor spar. [Fluor Spar.]

Cyanogen and calcium form a cyanide which has been but slightly examined; it is obtained by saturating hydrocyanic acid with hydrate of lime. It exists only in solution; by evaporation it is converted into formate of lime and ammonia.

Oxy-acids and lime combine to form a numerous class of salts; of these, the most important only are here described. Two of them—namely, the carbonate and sulphate—occur in great plenty in almost every part of the earth; the phosphate is more rarely met with.

Nitric acid and lime very readily combine and yield nitrate of lime (CaO, NO_5). It may be formed either by adding lime or chalk to nitric acid. A colourless solution is obtained, which is extremely bitter, and by evaporation long prismatic crystals are formed ($CaO, NO_5 + 4Aq.$); like the anhydrous salt, they are extremely deliquescent. These crystals dissolve in one-fourth of their weight of cold water, and in all proportions in boiling water; they are also very soluble in alcohol. Nitrate of lime is readily decomposed by heat; the residue gives a feeble light in the dark, and has been called *Baldwin's phosphorus;* it is stated to be composed of nitric oxide, nitrous acid, and lime, but when the heat is very long continued then pure lime is obtained. Nitrate of lime is often found in considerable quantity in spring water. It is applied to no use.

Carbonic acid and lime form carbonate of lime. [Calcareous Spar.]

Carbonate of lime (CaO, CO_2) constitutes the greater part of all shells, and enters into the composition of bones. Like sulphate of lime, it is found in most spring waters, held in solution by an excess of carbonic acid, and to this in part the hardness of water is owing.

By boiling water containing carbonate of lime dissolved in carbonic acid, the latter is expelled and the former precipitated. Such water will of course be softer than in its original condition, and hence carbonate of lime is said to produce *temporary* hardness, while sulphate of lime, not being affected by ebullition, gives *permanent* hardness to water. Both salts are decomposed by soap, which forms the familiar, insoluble, curdy precipitate (*margarate* and *stearate of lime*), and it is not until all the lime is removed in this way that a permanent lather can be obtained. Moreover, in using hard water for domestic purposes, that portion of the insoluble lime-soap precipitated in the pores of the skin, or in the fibre of fabrics submitted to cleansing operations, carries down with it, like the mordant in the process of dyeing, a portion of the colouring matter, the removal of which is the object of the operator. For these reasons, carbonate and sulphate of lime may be considered as impurities in water; at the same time, it must be borne in mind, that a certain quantity of these and other salts probably prevent lead from being dissolved from pipes through which the water

may pass, and thus form a guarantee against the poisonous effects of a solution of that metal. [WATER.]

Carbonate of lime may be artificially procured by several processes, as by passing carbonic acid gas into lime-water, or by adding an alkaline carbonate to a solution of any salt of lime in water. The precipitate is at first bulky, but in a short time settles so as to occupy comparatively little space. Carbonate of lime is insoluble in water, and decomposed by most acids with the evolution of carbonic acid gas. It is in various forms largely employed, as in lime-burning, glass-making, the reduction of iron, &c.

Sulphuric acid and lime form sulphate of lime (CaO, SO_3), frequently called gypsum, selenite, and plaster of Paris, on account of its being found in the neighbourhood of that city. It occurs largely in the mineral kingdom.

Sulphate of lime may be prepared artificially by several processes, as by mixing a solution of chloride of calcium or of nitrate of lime with one of sulphate of soda, or with dilute sulphuric acid. A bulky colourless precipitate is obtained when the solutions are moderately strong, which is sulphate of lime. This salt is nearly tasteless; it requires nearly 462 times its weight of boiling water for solution, and it is nearly as soluble in cold water. It is insoluble in alcohol. It is met with in most river and especially in spring waters, and, as before indicated, is one of the salts which imparts to them the property called hardness. The air has no effect upon it; the artificial as well as the natural crystals contain water, and the salt is composed of

1 Equivalent of sulphuric acid	=	40
1 „ lime . .	=	28
2 „ water . .	=	18
Equivalent	=	86

When heated, the water is expelled, but it has a great disposition to regain this water, and when it is made into a paste with water it becomes warm, and then a solid uniform mass in a few minutes. It is upon this property of losing water by heat and recombining with it by admixture with a small quantity that its use in taking casts, &c., depends. When sulphate of lime is exposed to a violent heat it melts, and yields an opaque vitreous globule. Sulphate of lime is not only used for taking casts, but occasionally as manure, or rather, probably, as a corrective of certain soils.

Sulphite of lime ($CaO, SO_2 + 2$ Aq.). Hydrate of lime absorbs sulphurous acid with facility; the compound forms a convenient source of sulphurous acid.

Oxalic acid and lime form oxalate of lime (CaO, C_2O_3). This salt exists in the form of calculi, and also in certain plants. It is readily procured by adding either oxalic acid, or, which is better, oxalate of ammonia, to a solution of a salt of lime. It is a white, extremely insoluble substance; it is dissolved by acids, except acetic acid, and decomposed at a high temperature, and converted first into carbonate and afterwards into pure lime. Oxalic acid and lime form so insoluble a compound, that they are used as tests of each other's presence.

Phosphoric acid and lime form several compounds, one of which occurs in nature. [APATITE.]

There are some other phosphates of lime; the ordinary triphosphate is prepared by adding a solution of phosphate of soda to one of chloride of calcium. A white powder, insoluble in water, but dissolved by acids, is precipitated. It is composed of

1 Equivalent of phosphoric acid	=	72
3 „ lime . .	=	84
Equivalent	=	156

or ($3CaO, PO_5$). [BONE-EARTH.]

Three-fourths phosphate is obtained by mixing a solution of phosphate of lime in phosphoric acid with alcohol. It is a white substance, which reddens litmus paper on account of the excess of acid; this excess is removed by water, and then the neutral phosphate remains. It is composed of

3 Equivalents of phosphoric acid	=	216
4 „ lime . .	=	112
Equivalent	=	328

Diphosphate of lime ($2CaO, HO, PO_5 + 4$ Aq.) occurs in irregular six-sided tables. It is soluble in solution of carbonic acid, and in this state is not unfrequently found in mineral waters. After heating to redness it contains

1 Equivalent of phosphoric acid	=	72
2 „ lime . .	=	56
Equivalent	=	128

Superphosphate of lime is the name given to a mixture of crushed burnt bones, oil of vitriol, and water, allowed to stand for a few days in a warm situation. Mixed with earth, it is largely used as a manure for land.

	No. 1.	No. 2.
Burnt bones . . .	2 parts	155
Sulphuric acid . . .	1	100 to 150
Water	3	200

No. 2 is more soluble than No. 1.

Chlorine and lime act upon each other in a peculiar manner, which is not as yet perfectly understood. When hydrate of lime is exposed to the gas, it absorbs nearly one-third of its weight, and the resulting compound has been called a chloride and a hypochlorite of lime. Although its exact nature has not been determined, it is a most important compound, and is used to a great extent for the purposes of bleaching, being frequently called *bleaching powder*. In solution it is employed as a disinfectant.

The properties of lime-salts are the following: They are colourless if the acid contained in them is colourless. They have a lower specific gravity than baryta or strontia salts; in other respects they much resemble the salts of these bases. Their solutions yield no precipitates with sulphuretted hydrogen, sulphide of ammonium, or a dilute solution of a sulphate, such as sulphate of lime, but are precipitated by carbonate of ammonia in the presence of chloride of ammonium. A soluble oxalate (*e.g.*, oxalate of ammonia) is an exceedingly delicate test for lime, precipitating that base from the most dilute solutions in the form of a white solid, insoluble in acetic acid, but soluble in hydrochloric or nitric acid.

CALCULATING MACHINES. [MACHINES, CALCULATING.]

CA'LCULUS is the general term for inorganic concretions of various kinds, formed in various parts of the body, and bearing a general resemblance in shape or composition to stones. The particles of which they are composed are frequently arranged by peculiar chemical affinities into regular forms; and in these, as in other crystals, the process may begin around a fragment of some other substance, such as a clot of blood, a pellet of mucus, or some foreign body, lying loose in the fluid which holds the elements of the calculus in solution. They are also formed by the mechanical aggregation about a nucleus, or otherwise, of particles of different kinds accidentally thrown together, and cemented into a mass by glutinous animal matter: or, lastly, they may be the product of secretion; the more fluid part of the secreted matter being conveyed away or absorbed, while the sediment gradually thickens and hardens into consistence, adhering perhaps to some rough surface or projecting point, or being deposited in a hollow where the accumulation is least liable to be displaced by friction or washed away by the fresh influx of fluid.

Tartar of the Teeth.—The most familiar instance of the last-mentioned kind of concretion is that which is deposited from the saliva and mucus of the mouth between the teeth, and upon their outer surface next the cheek. This affection is not only productive of deformity, but of considerable injury to the teeth, which become loosened by the displacement and absorption of the gums under the increasing pressure of the mass. It may easily be prevented by a little attention in the use of the brush, or remedied by the operation of *scaling*, which gives no pain, and should never be postponed when it is necessary. The substance deposited is gritty, of a dirty yellow colour, and goes by the name of *tartar*, though it has no connection with the vegetable product so called. It is stated to consist of the phosphate and carbonate of lime.

Salivary Concretions.—Similar deposites, consisting nearly of the same materials, occur under the tongue or in the substance of the cheek in the ducts which convey the secretion of the salivary glands into the mouth. They sometimes attain a considerable size, and require an incision for their removal.

Pulmonary Concretions.—Hard irregular masses of phosphate of lime, rarely larger than an almond, are frequently met with in the lungs of consumptive patients. They are sometimes found imbedded in the pulmonary tissue, to which they adhere intimately; but more frequently in the middle of tubercular deposits, especially when these take place in the substance of the bronchial glands. They occasionally find their way by ulceration into the air-tubes, and are brought up by coughing.

Calcareous Concretions in the Blood-vessels and Heart.—Brittle earthy deposits, consisting chiefly of the phosphate of lime, are exceedingly common, especially in advanced life, in the arteries, and in the valves of the left side of the heart, the cavities of which contain arterial blood. They are formed at first in nodules or scales, behind the membrane which lines these parts internally, and sometimes accumulate to such an extent as to convert the arteries into rigid tubes, and to impede or even stop the motions of the heart. They are frequently the cause of *aneurism* and other serious diseases, particularly a kind of mortification of the extremities called *senile gangrene*, and that distressing complaint, *angina pectoris*, which is often found to arise from rigidity of the arteries which supply the heart itself with blood. These concretions are not, however, so often productive of mischief as might be expected; for scarcely an individual passes the middle period of life in whom this ossification of the arteries, as it is termed, does not exist in a greater or less degree. The veins are likewise subject, but much less frequently, to small corpuscular concretions called *phlebolithes* (from φλὲψ, a vein, and λίθος, a stone). They appear to be formed behind the thin lining membrane, which, as they grow, is pushed forward into the calibre of the vessel, inclosing them in a kind of capsule, and forming a narrow pedicle by which they remain adherent. After a time they become detached and movable. When they occur in the veins upon the surface of the body, they may be removed if troublesome; but they are not in general of any consequence, and are seldom larger than a very small pea. They are

quite white, and consist of carbonate and phosphate of lime, combined with much animal matter.

Calcareous deposits are also found occasionally imbedded in the muscles (where however they partake more than in other situations of the fibrous nature of bone), on the surface of the spleen and pleura, in the brain, and other organs, and in various morbid growths of a cancerous, scrofulous, or fungous nature; as well as round foreign substances of any description retained in the body, and subject to the action of its fluids. They do not admit of classification, but all consist of combinations of lime with carbonic or phosphoric acid, and animal matter.

Chalk-stones.—Gouty and rheumatic persons are subject to the deposition of a matter thus denominated, and resembling half-dried mortar, under the skin, about the joints chiefly of the fingers and toes. They have been met with in severe and long-continued rheumatism of the head beneath the skin which covers the cartilage of the ear. They frequently excite ulceration, and when they protrude externally may be removed; but an operation is rarely resorted to. They are found to consist of *urate of soda.*

Intestinal Calculi.—The bowels are sometimes obstructed by rounded masses, formed by the agglutination of dry fibrous particles, such for instance as the fine down or beard of the oat, which is not entirely removed by sifting the meal. These concretions usually form round a small piece of bone, a plum-stone, or other such body. They are smooth and compact in their structure, but of small specific gravity; the fibrous matter of which they consist occasionally alternates with concentric laminæ of phosphate of lime, which usually forms a layer upon their surface. The circumstances which lead to their formation are obscure, but are possibly connected in some measure with constitutional predisposition, as they are found to recur habitually in the same person in spite of all precautions. The symptoms and most appropriate remedies for this complaint will readily suggest themselves; but its existence is in most cases rather suspected than ascertained till the calculus passes, as the symptoms may arise from other and very different causes of obstruction.

Gall-stones.—Calculi thus denominated are frequently found in the gall-bladder, or reservoir of the bile, which is attached to the liver, especially in persons who have reached the middle period of life, and have been long addicted to luxurious habits, or whose general health has been seriously impaired by mental distress or bodily ailment. They are often numerous, and one instance is recorded in which nearly three thousand were found at once. Generally, however, there are not more than three or four, and they are often solitary. They consist of one or more of the constituents of bile, with the occasional addition of phosphate of lime, and are white, or of shades intermediate between this colour, brownish yellow, and dark green. The white consist almost wholly of *cholesterine* (from χολὴ, bile, and στερεὸς, solid), a substance like spermaceti, first detected in the bile by Chevreul. The intermediate shades are composed of this substance, with more or less admixture of bile; and the darker kind seem to consist entirely of bile itself, inspissated. The last are rough and friable in their texture, sometimes much resembling cinders; the lighter varieties, on the contrary, are smooth and unctuous to the touch, presenting surfaces apparently flattened by mutual pressure. They are moreover distinctly crystalline, and sometimes lamellated, as if deposited in successive layers.

Biliary calculi are not productive of much inconvenience as long as they remain in the gall-bladder; but when they are protruded through the proper duct of that organ into the canal by which the bile passes from the liver into the intestine called the duodenum, they occasion great pain and disturbance of the health. The pain occurs in paroxysms, and is seated in the pit of the stomach, or a little lower and to the right, shooting to the back; and it is generally attended with vomiting and shivering, but not at first with a quickened pulse. If the bile be wholly obstructed, the evacuations lose their colour, and become unfrequent; the skin is tinged with a deep yellow, or *jaundiced*, as it is termed; rapid emaciation succeeds, with fever, and extreme dejection and weakness. The event is sometimes fatal, but in general the stone passes at length into the duodenum, the flow of bile is re-established, and the disturbance subsides. The best remedies are emetics, aperients, *opium*, the warm bath and fomentations, and occasionally bleeding.

Urinary Calculi.—The urine is a very complex fluid, holding in solution at least twelve different ingredients in health, and more in disease. Some belong to the class of acids, as the uric, phosphoric, and oxalic; others are alkaline or earthy, as ammonia, soda, lime, and magnesia. In certain conditions of the system these elements are no longer kept in complete solution, but are precipitated or combined in a solid form, constituting various kinds of crystalline or sedimentary deposits, often arranged in successive layers; thus inducing those well-known affections, *gravel* and *stone in the bladder.*

Renal Calculus and Gravel.—Urinary concretions for the most part originate in the *pelvis* or hollow part of the kidney, either as small stones, or in the form of minute sand-like crystals. In this situation they are called *renal* calculi (from *ren*, the kidney). They may remain there permanently, and even attain a considerable size, so as to distend the cavity and cause absorption of the gland itself, without more inconvenience than an occasional sense of weight and a dull

aching in the loins. They may also produce inflammation and abscess of the kidney, which sometimes ends in the discharge of the stone with the other contents of the abscess through an ulcerated opening in the back; and sometimes in a lingering death. More commonly the deposite is carried with the urine, while yet of small size or in the form of sand, into the *ureter* or duct of the kidney, along which it descends more or less slowly into the bladder, with symptoms much resembling those which attend the passing of a gall-stone. These are shivering, sickness of the stomach, pain shooting in paroxysms from the back to the groin, and down the thigh of the same side; and, in males, retraction of the corresponding testicle. The circulation does not partake in the disturbance unless the calculus be so large as to obstruct the ureter, and thereby excite inflammation of the kidney. These symptoms constitute what is called *a fit of the gravel*, and generally terminate in the expulsion of the offending matter with the urine, which is not effected without much pain in the neck of the bladder and the urethra; the urine being voided in small quantities and with difficulty, and occasionally mixed with blood. The remedies employed in gall-stone afford relief in a fit of gravel. Copious draughts of some mild warm fluid should also be taken, with small doses of alkaline or other medicines, suited to the nature of the deposite.

Vesical Calculi.—It sometimes happens that a renal calculus, having reached the bladder in the manner described, is detained there, and becomes the nucleus of fresh concretions. Vesical calculus may also be formed upon a foreign body, such as the broken end of a catheter, or upon a small stone which has made its way inwards. Nuclei of this last kind are formed originally in the ducts of the prostate gland, which surrounds the male urethra just where it issues from the bladder, and consist of phosphate of lime.

In whatever way it may first arise, *vesical calculus* or *stone in the bladder* is one of the most dreadful maladies to which man is exposed. Even in its nascent state, but most certainly when it becomes at all large, the stone occasions excruciating pain. This is seated chiefly in the neck of the bladder where the stone usually rests, and, by sympathy, in the urethra near its external orifice: it is attributable, in a great measure, to the strong spasmodic contractions of the bladder upon the stone, and is most severe immediately after micturition. Hence, fortunately, it is intermitting; for when the bladder is full, the weight of the stone is partly sustained by the fluid, and it does not touch the sensitive internal membrane in so many points. In some cases the pain is more endurable than in others from peculiarity of constitution, or the comparative smoothness and lightness of the stone; but sooner or later the period of agony arrives; the bladder becomes intolerant of the smallest amount of distension, so that the urine is voided, as it enters, drop by drop, mingled with blood and mucus; and at length the patient inevitably dies, worn out by unremitted suffering.

There are remedies which are capable of affording a certain amount of relief for a time; but the only means that offer even a chance of a happier termination than death itself, are the removal of the cause by an operation. The stone must either be withdrawn through the urethra by a properly constructed instrument, which often succeeds when it is small in the male, and seldom fails in the female unless it be large; or it must be drilled and crushed into fragments small enough to be voided with the urine, according to a brilliant method of operating lately brought into notice [LITHOTRITY], or an incision must be made large enough to permit its extraction [LITHOTOMY]; a method practised by the ancients, and unfortunately by no means superseded (as some imagine) by lithotrity, which is out of the question in very young children, and often inapplicable in more advanced life. This disease is curable by the various means that have been devised, or a combination of them, in perhaps five or six out of seven cases, even in its advanced stage; and the average number of failures in young children does not amount to one in fourteen. It is always advisable that an operation should not be delayed when the existence of stone is proved, which, it may be observed, can only be done by actually striking it audibly with a metallic instrument called a *sound*; for not only is the stone constantly increasing in size, but the parts concerned may become incurably diseased in consequence of delay, or the general health may sink beyond the power of restoration. The idea of dissolving the calculus is a dream.

It is a curious fact in the history of this disease, that it is exceedingly common in some places and very rare in others. Thus at Norwich and Paisley together there are probably more cases in a year than in the whole of London; while at Hereford the disease is almost unknown. No researches into the cause of this difference have yet afforded a satisfactory explanation of it.

It would be tedious to enter at length into the chemical nature of urinary calculi. In weight they vary from a few grains even to several pounds, but seldom exceed a few ounces. They have been distinguished (chiefly by the labours of Dr. Wollaston) into the following kinds, which are here arranged nearly in the order of their frequency:—

1. Uric acid.
2. Oxalate of lime, called also the *mulberry* calculus, from its dark colour and rough surface.
3. Ammoniaco-magnesian phosphate; called also the triple-phosphate.

4. Phosphate of lime, or bone earth calculus.
5. The fusible calculus, a combination of the last two species; so called from its fusibility under the blow-pipe.
6. The mixed calculus; composed of several of the other kinds confusedly mixed.
7. Urate of ammonia.
8. Carbonate of lime.
9. Cystic oxide.
10. Xanthic oxide.

The three last are extremely rare. The phosphatic varieties generally include a nucleus of the first or second species, and are found chiefly in advanced life, or in cases of long standing.

The substance called uric acid, of which probably three-fourths of the concretions in question consist wholly or in part, is sparingly soluble in water unless an alkali be present in a quantity more than sufficient to neutralise it; and from such a solution, of which healthy urine is an example, the addition of almost any other acid will precipitate either the urate of the alkali or the uric acid itself in the form of powder. To this peculiarity is probably due the formation of chalkstones—consisting, as we have seen, of urate of soda—in those who are subject to gout, as well as the proverbial liability of such persons to gravel and other calculous disorders; for in this complaint acetic acid is so abundantly generated as to be observable in the perspiration. Children also, in whom the food is so apt to turn sour upon the stomach, are much more liable to stone than the middle-aged, and their calculi almost invariably consist of uric acid. In such cases the alkalies and absorbent earths are of eminent service, by preventing the admixture of free acid in the urine, which is thus rendered more capable of retaining the urates in solution. These medicines, on the other hand, are extremely injurious if the phosphates happen to prevail, when acids should take their place, for reasons somewhat analogous. These considerations may have their use in pointing out the propriety of attending to the diet and the digestive functions, with a view to prevent or correct the formation of urinary concretions; and they no less forcibly illustrate the necessity of a knowledge of chemistry on the part of those who are intrusted with the treatment of such disorders, that the different kinds may be justly discriminated. This can only be done by a careful analysis of the urine and its sediments; a process which will be explained in the article on URINE.

Calculi in Inferior Animals. - *Biliary Calculi* are rare in the horse and the deer, for these animals have no gall-bladder, and the hepatic duct is large and straight, and the bile flows through it as fast as it is secreted. They are often found in the gall-bladder of the ox, sheep, and dog. There is scarcely a stall-fed ox slaughtered from Michaelmas to Lady-day in which they do not exist of large size or in great numbers; sometimes there is only one concretion, but that of considerable magnitude. In an ox that died of jaundice a gall-stone was found which weighed 15 oz. when first removed from the bladder. More frequently there are numerous calculi of a small size, scarcely larger than grains of sand, or many of them agglomerated together, forming a rounded or irregular body, from the size of a pin's head to that of a millet seed. More than 800 have been counted in the gall-bladder of one beast. Occasionally there is found an irregular crystallised body of a green or azure blue colour, glistening and polished. This forms a valuable pigment. The cause of these concretions is not well understood, but it depends greatly on want of exercise and impaired digestion. In the grass-fed ox they are seldom found. These calculi may exist in the gall-bladder without apparent injury to the health, but occasionally they press upon and close the passage through which the gall should be conveyed to the intestinal canal; or they enter into the hepatic duct and obstruct it, and prevent the flow of the bile through it; or, being numerous and large, they may by their presence and weight and friction irritate the mucous membrane of the cyst, and produce disease. [BILE, and DIGESTION, NAT. HIST. DIV.; JAUNDICE.] If the existence of inspissated bile, or biliary calculi, in the gall-bladder were indicated by a certain train of symptoms, the experience of the farmer would supply a ready and almost certain cure. The stall-fed ox has the gall-bladder partially filled with minute or larger concretions. The grass-fed beast in June will rarely furnish one. The former was idle and over-fed; the latter was compelled to exert himself a little in order to obtain his food, and he was kept under the salutary aperient influence of the newly-sprung grass.

Biliary calculi have been observed in the gall-bladder of almost every domestic quadruped, and very often in poultry. They differ materially in their composition, but agree in being crystallised bodies, formed of layer upon layer, and containing margaritic acid, animal mucus, a yellow colouring matter, and salts, principally phosphate of lime and magnesia.

Cerebral Calculi have been found more frequently in the horse than any other quadruped. They are contained in the ventricles of the cerebrum or the cerebellum, and attached to or enveloped by the plexus choroides. They are usually white, variously formed, of a stony hardness, and consist nearly of pure phosphate of lime. No peculiar symptom indicates the existence of the calculus, but the horse is suddenly attacked by inflammation of the brain and dies; upon examination the ventricles are found distended with fluid, and these concretions attached to the plexus of vessels. Afterwards, perhaps, it is recollected that the animal had been somewhat dull and stupid, sleepy,

and self-willed, and had frequently hung his head; that, in fact, there had been something wrong about the head. The irritation produced by the foreign body had been long existing and increasing.

Gastric Calculi are rarely or never found in the stomach of the horse; but they are of frequent occurrence in ruminants. Concretions varying from the weight of a few ounces to seven or eight pounds have been found in the paunch of cattle. There are traces of concentric layers in all of them, but they are far from being regular. There is usually some central nucleus, such as a small bit of nail or stone, around which has been collected a mass of earth and food and hair, cemented by the mucus of the stomach. When loose in the rumen, they acquire a globular form, but, having been confined in one of the compartments of that viscus, they are occasionally flattened, and in a few cases angular. The symptoms by which their presence is indicated are not well known, nor the effects which they produce; but one thing of some importance is certain, namely, that they are seldom found in healthy and thriving cattle. They may be either the cause or the consequence of disease, and much may be said on both sides. The method by which they may be dissolved or otherwise got rid of is unknown. A different kind of concretion is found in the abomasum or fourth stomach of cattle, and particularly of calves. It is composed almost entirely of hair, agglutinated by the mucus of the stomach. Cattle are frequently observed to spend a considerable time in the friendly office of licking each other: a portion of the hair mixed with the saliva is occasionally swallowed; and, not possessing sufficient solidity or weight to break through the roof of the paunch and enter that stomach, it passes along the œsophagean canal to the fourth stomach, where, by the peristaltic motion of that stomach, it is formed into a ball. There are no symptoms which clearly indicate the presence of these balls, nor is it plain by what means they could be expelled; but it is very evident that they have an injurious effect, producing distension of the paunch and loss of digestive power in the fourth stomach; the first by sympathy, and the latter by their direct presence. The animals in which these hair-balls are found after death were never well conditioned or healthy, and those that have expelled a hair-ball by stool have immediately begun to thrive.

Similar balls, but composed of felted wool, with portions of different kinds of food and various earthy and saline matters, mixed up with the mucus of the stomach, and having undergone a process of crystallisation, are found in the fourth stomach of the sheep, the goat, the chamois, the antelope, and the deer. They have usually a small nucleus, but the structure of the surrounding mass and the form of the whole admit of much variety. [BEZOARS.]

Intestinal Calculi are often found in the horse. They have almost invariably some central nucleus, as a seed, a small stone, or a bit of nail, around which particles of food and saline matters have accumulated and crystallised. They differ from the gastric calculi in the greater portion of earthy and saline matter of which they are composed, and scarcely a trace of food is detected in many of them. The concentric layers are well defined, and the ball, when dried, will bear a beautiful polish. They assume different forms, according to the portion of intestine which they occupy. In the colon they adapt themselves to the shape of the cells of that viscus, and represent a kind of four-sided prism; at the fundus, or base of the cæcum, they are globular. Twenty or thirty of the cells of the colon will sometimes be occupied by them, varying in weight from half an ounce to three-quarters of a pound. In the cæcum, a single concretion has occasionally weighed eight or ten pounds.

They are oftenest found in heavy horses of slow work. Mill-horses are also subject to them, and horses that are fed on much dry bran. The symptoms of their existence are obscure, and can scarcely be distinguished from those of colic. They have occasionally been expelled in the act of purging, but it would generally be a fruitless and a dangerous attempt to dislodge them, for they are embedded in the cells of the colon or the blind pouch of the cæcum. They destroy the horse by the irritation which they occasion, and by their weight, and especially in the concussion of rapid action they rupture the parietes of the intestine. It would seem almost incredible that they should remain so long as those of larger size must necessarily do. Many months or years must have passed away in the formation of a calculus that ultimately weighs eight pounds. There is scarcely a case in which they have occasioned the death of the animal, where careful inquiry will not elucidate the fact, that during a very long time the animal had experienced occasional attacks of apparent colic.

Salivary Calculi are oftener found in the herbivorous animal than in the human being, because there is a greater expenditure of saliva in mastication, and the salivary glands are larger and more susceptible of inflammation. They mostly exist in the parotid duct. They are of a dead-white colour, usually of an oblong form, of considerable density and specific gravity, and the surfaces highly polished or capable of being so. They are only injurious when they completely obstruct the duct: then the salivary fluid, continuing to be secreted, accumulates behind the calculus, and the canal becomes distended, and will burst, unless an incision is made upon the calculus, and the obstructing body removed.

The salivary calculus of the horse consists of 86 parts of carbonate of lime, 6 of animal matter, 4 of water, 3 of phosphate of lime and other salts, and 1 of mucous matter.

Urinary Calculi.—These, whether found in the kidneys, or ureters, or bladder, or urethra, have been observed in almost every domesticated animal. In the horse, a urinary calculus has occupied the whole cavity of the kidney and has weighed more than a pound. It has obstructed the ureters, and destroyed the horse and the ox: it has completely filled the bladder of the dog, and has been shivered into a thousand pieces by the sudden fall of the animal from a considerable height. In the urethra also it has been productive of fatal inflammation in the dog. In almost every animal sand has occasionally occupied the fundus of the bladder. Minute calculi have been found in almost countless numbers, or one large calculus has produced extreme pain, suppression of urine, and destructive inflammation. In most of these cases means have been found to allay to a certain degree the irritability of the bladder, but no medicine has the slightest solvent power on the calculus. The operation of lithotomy has been performed with success on almost every domesticated quadruped, and that of lithotrity has been effectual in the horse.

Nearly the same constituent principles enter into the composition of these calculi in the herbivorous animals. The carbonate of lime prevails; there are, on an average, 83 parts out of 100 of it in the urinary calculus of the horse; 87 in that of the ox, and 91 in that of the ass; the remainder is made up of subphosphate of lime and animal cement. In the hog, however, ammoniacal phosphate of magnesia is, with the animal cement, nearly the sole material. In none of them has uric acid been detected.

The concretions which are found in other tissues and organs differ little from those in the human being.

CA'LCULUS, CALCULATION. The word *calculus* means a small pebble, such as was made use of in teaching or practising *calculation*. We must refer to articles of a more specific kind for different methods of calculation, but as regards this individual word, we have only to draw the distinction between it and *mathematics*. Generally speaking, a calculator is taken for a mathematician; which he may or may not be. Mathematicians are sometimes fond of and skilful in calculation, and sometimes the reverse of both: Euler and Wallis are instances of the former; Lagrange, according to report, of the latter. To perform a calculation is to put numbers together by rules, the reasons of which may or may not be understood by him who uses them. It is true that a mathematician must, in the process by which he becomes such, increase his power of calculation; but whether he will ever attain the expertness and correctness of a banker's clerk in the commonest operation, depends upon qualities of mind which have little or nothing to do with his *mathematical* power. It is necessary to caution our readers not to take a result as *mathematically* correct, because it is produced by a skilful calculator; or as *numerically* correct, because it has been worked by a good mathematician. The method of the first, and the work of the second, may be wrong, without any inference against either in relation to his peculiar pursuit.

The term *calculus* is commonly applied to signify any branch of mathematics which may involve or lead to calculation: any, in fact, except pure geometry. Thus, the part of algebra which relates to exponents and logarithms is sometimes called the exponential *calculus*. The references immediately following are to those branches which, without any particular reason, have permanently acquired the name of *calculi*. And, the word being now completely introduced, every new specific development of any part of mathematics will receive the name. Thus, the calculus of definite integrals, the calculus of discontinuous functions, &c., are terms which are beginning to be used. In fact, a *calculus* may now be defined as any method in which questions are treated in classes by general rules.

CALCULUS, DIFFERENTIAL. [Differential Calculus.]
CALCULUS, INTEGRAL. [Integral Calculus.]
CALCULUS OF FUNCTIONS. [Functions, Calculus of.]
CALCULUS OF VARIATIONS. [Variations, Calculus of.]
CALDARIUM. [Bath.]
CALENDAR. [Kalendar.]

CALENDERING is a general name applied to the processes of smoothing, dressing, and glazing webs or textile fabrics of cotton and linen, either to prepare them for the operations of the calico-printer, or to impart the last finish to the goods before they are folded and packed for the market.

The common domestic smoothing-iron affords the simplest illustration of the process of calendering. The mangle, which is so frequently employed as a substitute for the smoothing-iron, presents another form, the operation of which is identical with that of some of the earlier calendering machines. In the common mangle, as in the old calenders constructed on the same principle, the cloths to be smoothed are coiled upon smooth wooden rollers, and laid between two hard flat surfaces. The lower surface is immoveable, but the upper, which is formed by the bottom of a large heavy box, is capable of being moved backwards and forwards in the direction of its length, thereby causing the cloth-covered rollers to roll backwards and forwards until every part of the cloth wrapped upon them has received sufficient compression. In a common mangle the alternate motion of the pressing-box, which is usually loaded with stones, is produced by turning a winch-handle, which alternately winds and unwinds ropes extending from the ends of the box to a drum or cylinder fixed over it. To obviate the inconvenience occasioned by the frequent changes in the direction of the motion required, various ingenious devices have been resorted to, by which the alternating motion of the loaded box is produced by a continued motion of the winch-handle in one direction. Being larger and heavier than common mangles, the old calenders made on the same principle were often worked by a horse-wheel, or some other moving power. The process of calendering was greatly improved by the invention of a machine in which the pressure is produced between cylinders, instead of between cylinders and flat surfaces, and in which, consequently, the alternating motion is got rid of; it is easier, too, by such a method to give a uniform and equal pressure. According to some authorities the cylindrical calendering engine was introduced into this country from Flanders and Holland by the Huguenots, who were driven to England by persecution. The rollers or cylinders were formerly made of wood; but, as it was found impossible to overcome the tendency of that material to warp and crack, they are now usually made either of paper or of cast-iron. The paper cylinders, which form the most remarkable feature of a modern calender, are formed in the following manner. The axis is a strong square bar of wrought-iron, and the body of the cylinder consists of a great number of circular pieces of stout pasteboard, each of which has a square hole in the centre to receive the axis, and six smaller round holes at equal distances from each other, near the periphery. A strong cast-iron plate, of a circular form, but rather smaller than the pieces of pasteboard, and perforated in like manner, is first put upon the axis, and then a sufficient number of pieces of pasteboard to form, when compressed, a cylinder of the required length. Another cast-iron plate is then added, and long cylindrical bolts of wrought iron, each of which has a head at one end, and a screw cut upon the other, are put into the six holes near the rim, and passed completely through the mass of pieces of pasteboard and the end plates of cast-iron. Nuts being put upon the ends of these bolts, the whole is screwed up as tight as possible, after which the cylinder is exposed to a strong heat for several days in a stove or heated chamber. By this process the pasteboard is considerably shrunk, and while it remains hot the nuts are repeatedly tightened up as much as possible. When allowed to cool the pasteboard is inclined to expand again, while the iron bolts contract, so that the mass of paper of which the cylinder is composed becomes almost inconceivably hard and dense. It is finished by very careful turning in a lathe, by which the surface of the cylinder is rendered perfectly true, and receives, in consequence of its extreme compactness, a very high polish. Iron cylinders, which are used in conjunction with paper cylinders in the same machine, are made hollow, and, for cases in which the application of heat is required, are constructed either to receive red-hot rollers or heaters, or to admit steam through a stuffing-box in the axis at one end, and discharge it at the opposite extremity.

The calenders now commonly employed for smoothing cotton and linen goods, contain four or five rollers, mounted above one another in a strong frame-work of cast-iron, which, from its ability to bear the application of heat without warping, is preferable to wood. If the object be simply to smooth the fabrics, the motion of the rollers, which can be made to bear against one another with any required degree of pressure by means of weighted levers, is so adjusted that, though their relative diameters may vary, their surfaces travel with equal velocity, so that no rubbing contact is produced. For some goods, however, especially those intended for use in household furniture, and in certain articles of dress, a glazed or polished surface, as well as mere smoothness or evenness, is required. Such goods were formerly glazed by hand upon an inclined table, with a rounded piece of polished flint attached to an apparatus which enabled the operator to preserve the cloth at a proper degree of tension, and to rub the flint backwards and forwards with considerable force over the surface, a small portion at a time. This process is now far more expeditiously performed with a calender of the ordinary construction, with the addition of a series of toothed wheels which cause the rollers to move with different velocities, so that the surface of one will rub or slide upon the surface of that adjacent to it. By the ordinary process of calendering, and still more by the use of the glazing calender, the round threads of which the web is composed are flattened, so that, by the diminution of the interstices, the fabric is made to appear closer than when it leaves the loom. Lawns, muslins, and other very light transparent fabrics are calendered with a very slight pressure, in a machine often worked by hand, which has the effect of smoothing the goods without altering the cylindrical form of the threads. The watered or "chine" goods exhibit in a remarkable way the effect produced by a partial glazing, or by imparting to the round threads a partial flattening in different directions.

When the operation of the calender is intended to finish goods for the market, it is immediately followed by folding and packing. The late Dr. Ure described a very complete calendering apparatus in use among the calico-printers of Alsace, to which a self-acting folder may be attached at pleasure. In the large establishments of Lancashire, the cotton goods are subject to immense pressure in a hydrostatic press, by the aid of which they are frequently made up into bales with such compactness as to occupy one-third less space than they could do if packed by hand in boxes. The calendering of goods in the process of manufacture is closely connected with the operations of the bleacher and calico-printer; but the calendering of finished goods is usually performed by the packer.

The process of calendering being comparatively simple, it has not undergone so many improvements within the last few years as other departments of the cotton manufacture. The change is mostly in the vastness of the operations. Manchester being the great market for Lancashire, in all that concerns the cotton trade, the calendering and packing are conducted on a stupendous scale in that city,—not only hydraulic machines being employed to give the pressure, but also steam-engines to work those machines.

It is not possible to state the extent of this trade; for it is optional to a manufacturer to determine which of his goods shall undergo a regular process of calendering.

CALENDS. [KALENDS.]

CALENDULIN. A mucilaginous matter of unknown composition, found in the leaves and flowers of the *Calendula officinalis*.

CALF. [COW.]

CALICO. [COTTON.]

CALICO-PRINTING, the art of dyeing woven fabrics of cotton with variegated figures and colours more or less permanent. It has been practised from time immemorial in India, upon the kind of cotton cloth called calico, which is supposed to have derived its name from the town of Calicut.

History.—There are very few dye-stuffs capable by themselves of imparting to cotton colours of sufficient lustre and durability combined. They must in general be rendered fast as well as brilliant, by the intervention of certain substances, which, in consequence of their attraction for the textile filaments and the colouring matters, form a bond of union between the two, and are on that account sometimes called *bases*, and at other times *mordants*. The last-named substances are so called from their taking firm hold of, or biting, the dyes. These intermediate bodies, though colourless themselves, generally possess the power of modifying more or less the colour of the dye, or of producing from the same dye-stuff different tints; so that a piece of white cloth, after being imbued with various mordants, will assume various colours in a single dye-vat. Thus if white calico be impressed with the mordant of acetate of alumina in one set of lines, with that of acetate of iron in a second, and with a mixture of these two mordants in a third, on being exposed to a solution of madder-dye for a proper time, it will become permanently printed in red, black, and chocolate stripes.

Although this scientific chemical process would seem to be characteristic of the refinement of the present time, yet it was known to the ancient Hindus and Egyptians. Pliny describes it with sufficient precision. "Robes and white veils are painted in Egypt," says he, "in a wonderful way; being first imbued, not with dyes, but with dye-absorbing drugs, by which they appear to be unaltered, but when plunged for a little in a cauldron of the boiling dye-stuff, they are found to be painted. Since there is only one colour in the cauldron, it is marvellous to see many colours imparted to the robe, in consequence of the modifying agency of the excipient drug. Nor can the dye be washed out. Thus the cauldron, which would of itself undoubtedly confuse the colours of cloths previously dyed, is made to impart several dyes from a single one, painting while it boils." *

In India, where manufacturing processes have probably suffered little change in the course of three thousand years, not only is the art of using mordants well known, but that of applying resist pastes, in order to preserve the cloth from the action of the dye-bath in any desired figures or spots. In the Societé Industrielle of Mulhausen, a town of great celebrity in calico-printing, may be seen specimens not only of modern Indian calicoes in the preparation state, topically covered with wax, to serve as a resist to the indigo dye, but of ancient styles of pencilled cloths, which had been the work of princesses, covered with figures of such complexity as could not be made without a very tedious and costly education, beyond the reach of ordinary artisans. Among other curiosities, the counterpane of a state bed is shown, six yards long and three broad, which must have taken a lifetime to execute, on their plan of applying the melted wax with a pencil. How far this differs from the peculiar mode of producing Indian handkerchiefs, may be seen under BANDANNAS.

Processes of printing, similar to the Indian, have been long practised in Asia Minor and in the Levant; but they were not attempted in Europe till about the middle of the 17th century, when extended commerce had made the brilliant colours of the eastern world objects of general admiration and desire. Anderson, in his 'History of Commerce,' places the origin of English calico-printing as far back as the year 1676; but Mr. Thomson, of Primrose, near Clitheroe, a better authority, assigns the year 1696 as the date of the commencement of this art in England, when a small print-ground was established on the banks of the Thames, at Richmond, by a Frenchman. The first large establishment of the kind was at Bromley-hall, in Essex. It was not till the year 1768, however, that the business was carried into Lancashire, where it now constitutes one of the most interesting and productive branches of English manufacture. From its outset, the printing of cotton goods encountered the keenest hostility from the silk weavers of Spitalfields, who in the year 1680, and often afterwards, assailed in a riotous manner the East India House, on account of the Company importing the chintzes of Malabar. The English government gavè way to the remonstrances of the silk trade, and imposed, first of all, heavy duties on Indian calicoes, and in 1700 prohibited their importation altogether. This law became nearly inoperative, in consequence of the excessive penalties annexed to its infraction. So little were the principles of free commerce understood, that in 1720 the wear of all printed calicoes whatsoever, foreign and British, was prohibited by a new law, passed for the purpose of allaying the clamour of the woollen and silk manufacturers; but in 1730 parliament was pleased to permit British calicoes only, made of cotton weft and linen warp, to be printed and worn, on paying a duty of 6*d*. the square yard. It was not till 1774, and after a most expensive application to parliament, that cloth made entirely of cotton was allowed to be printed; in spite of the manifest fact that cotton cloth was far better adapted to the purpose than the mixed webs of linen and cotton, which took the colours unequally, owing to the unequal attraction of these two fabrics for dyes. The calico-printing of this country continued to groan under the most oppressive fiscal laws till the year 1831, when they were finally repealed, and the business was left to its natural rate of development, under the taste, science, and capital of the country. Since that time it has increased to a prodigious extent.

Linen was long ago, and silk and woollen fabrics more recently, made the subjects of topical dyeing, upon principles analogous to those of calico-printing, but with certain peculiarities, arising from the nature of their textile materials.

Processes.—Calicoes, muslins, &c., intended for printing must be first of all freed from their fibrous down; which is effected by the action of the singeing machine. This consists either of a semi-cylinder of cast-iron laid horizontally, and kept at a bright red heat by a furnace, or of a horizontal range of gas-jet flames: over one of these the plane of cloth is drawn with a steady continuous motion, and at a rate suited to its texture. When gas-flames are employed, a line of suction-tubes is placed over the extended web, to draw the flame up through the interstices of the cloth, which effectually clears the threads from the loose fibres. Some manufacturers singe the goods as they come from the loom; but it is generally deemed preferable to previously wash out the weaver's dressing at the dash-wheel, and then dry and calender the woven fabric.

The cotton cloth, after the singeing, must be next well bleached, because the whiter it is the more light will it reflect from its surface, and the more brilliant will be the colour of its dyes. The first step in the bleaching process is that of boiling the cloth in an alkaline bath, which for delicate fine goods consists of a weak solution of soda, and for stronger articles slaked lime and water. For this purpose a bowking apparatus merits the preference. It consists of a large egg-shaped cauldron, with a flat false bottom placed a little above the rounded true one, to protect the cloth from the danger of being scorched by the fire. Through the centre of the false bottom a vertical pipe rises from near the real bottom to somewhat higher than the top of the cauldron, and carries a conical cap (umbrella-wise) above its open mouth. The boiler being filled with goods, and supplied with a proper quantity of the detergent liquid, is securely covered with a dome-shaped lid. Whenever ebullition becomes active, the steam forces a continuous stream of liquid up the central pipe, causing its overflow, whereby the goods are irrigated and soaked with the boiling hot ley of lime, soda, or potash. During its descent it is partially cooled, but on reaching the bottom it recovers its ascensional power by the agency of the steam, and thus circulates up and down as long as the heat is maintained. The cauldron having been allowed to cool a little, the goods are removed, and subjected either to the rinsing operation of the dash-wheel, or to the proper rinsing machine. This consists of a range of wooden rollers in pairs, each lying upon its fellow, mounted in a horizontal plane upon the top edges of an oblong wooden cistern filled with water, with single roller-pins at the bottom of the cistern, in correspondence with the top ones. The beginning of a series of webs stitched together at the ends being introduced between the roller-pins above and round the roller-pins below, the last or traction roller is placed in connection with the moving power, while a stream of pure water is made to flow through the cistern; the cloth is thereby alternately squeezed between the top rollers and immersed in the water, so as to get effectually rinsed with hardly any manual labour. In some calico print-works, this rinsing apparatus occupies a length of 40 or 50 feet. The goods are next steeped for a few hours in a leaden or wooden cistern, containing a weak solution of chloride of lime. They are once more rinsed. They are now boiled in an alkaline ley, made of crude soda dissolved in water, and freed from its impurities by filtration or subsidence. The goods are again rinsed, and finished by a steep in sulphuric acid very largely diluted with water; this removes any adhering particles of lime or iron, which would be apt to give the cloth, after some time, a yellow tint. They are last of all rinsed, dried, and sometimes smoothed under the calender. If they are not calendered, they are run through a machine called in Lancashire the *candroy*, which spreads them smoothly in the act of rolling them upon a cylinder.

The process of bleaching, here described, is adopted as a preliminary to calico-printing. The larger operations, for the production of white or unprinted goods, are noticed under BLEACHING.

The cloth is now supposed to be ready for the printing processes, which we proceed to describe,—first, in relation to the mechanical apparatus, and then to the chemical ingredients.

* Natural History, book xxxv. chap. ii.

There are four modes of printing calicoes and muslins. The first is by small wooden blocks worked by hand; the second by large wooden blocks, set in a frame, and worked by a machine called the *Perrotine* (from the name of its ingenious inventor, M. Perrot, of Rouen); the third, by flat copper plates (a method now nearly obsolete); and the fourth, by copper cylinders, mounted in a machine of great elegance and productive powers, called a one, two, three, four, &c., coloured calico-printing machine, according as it is mounted with one, two, three, four, or more cylinders. The last colour is generally applied by what is called a surface cylinder, covered with figures like types in bas-relief.

The blocks for the first of these four methods are made of sycamore wood, or of deal faced with sycamore. They are about ten inches long and five broad, with an arched handle on the back. The face is either cut in relief into the design required, or the same object is obtained by the insertion edgewise into the wood of narrow slips of flattened copper wire, in the desired configurations. These narrow fillets have one edge inserted into the wood, are fixed by the taps of a light hammer, and are filed down and polished into one horizontal plane, to secure equality of impression in the several lines. The interstices between the copper ridges are filled up with felt-stuff. Occasionally both the wood-cutting and insertion plan are combined in one block.

Calico-printing by hand is performed by applying the face of the block to a piece of woollen cloth stretched over one end of a sieve-hoop, and imbued with the colouring matter of a thin pasty consistence by means of a flat brush. The block is then applied to the surface of the cotton cloth while extended upon a flat table covered with a blanket, and the impression is transferred to it by striking the back of the block with a light mallet. This method, besides the great cost of labour which it involves, has the inconvenience of causing many irregularities in the execution of the work. It has been superseded to a considerable extent, both in France and Belgium, by the Perrotine, a machine adverted to in a preceding paragraph. Three thin wooden blocks, engraved in relief, about three feet long and from two to five inches broad, are successively brought to bear on three of the four faces of a prismatic roller of iron, round which the cloth is successively wound. Each block rests on springs which enable it to press with the delicacy of a skilful arm; and each receives its proper-coloured pigment from a woollen surface imbued by a mechanical brush in rapid alternation. One man, with three children for superintending the three colours, can turn off about thirty pieces English in a day, which is the work of fully twenty men and twenty children in ordinary block-printing. To print a piece of cloth by hand the block must be applied 448 times for each colour. The machine, moreover, may be conducted by persons with little manual dexterity, and therefore entitled to comparatively low wages. The use of the Perrotine is spreading rapidly into every quarter of the continent, even into Russia. It executes a style of work different in some respects from that of the cylinder.

This latter machine, which is now the chief characteristic of English print-works, is a hollow cylinder of copper, fully three feet long, and three or four inches in diameter, whose surface is engraved with the required device. This engraving is effected, not by the hand-graver, but by the mechanical pressure of a steel roller from one to two inches in diameter and three inches long, which transfers the figures engraved on it to the relatively softer copper. The first steel roller, called the die, is softened before being engraved in intaglio; it is then hardened, and made, by a powerful press, to transfer its design in relief to a similar die called the mill, which is the one used for transferring the design to the copper cylinder. The process of etching is also sometimes had recourse to for covering the cylinder with various figures.

The engraved cylinders are mounted upon a strong iron shaft or arbor, carrying a toothed wheel at its end, in order to put it in train with the rotatory printing-machine, for one, two, or more colours. On a roller, at the upper part of this apparatus, are wound whole calico webs stitched together, the end of which is then introduced between the engraved copper cylinder and a large central cylinder covered with blanket, against which it is made to bear with regulated pressure. The engraved cylinder turns on the top of another cylinder covered with woollen cloth, which revolves with the former while its under part is plunged in an oblong trough containing the colouring matter in the state of a paste. The engraved cylinder is thus supplied with an abundance of impressible colour, and is cleared from the superfluity by the thin edge of a flat ruler made of bronze, called vulgarly the doctor (*ductor*), which is applied obliquely to it with a gentle force. The cylinder, after its escape from this wiping tool, acts upon the calico, and rolls it onwards with its revolution, imparting its figured design with great precision.

Three and four-colour machines are now made at Manchester of such excellence that they will print a piece of twenty-eight yards per minute, each of the three or four cylinders inserting its distinct colour or mordant into the pattern. At this rate the astonishing length of nearly one mile of well-coloured designs of exquisite beauty is printed in an hour. Such is the combined result of mechanical and chemical science, each of them brought to a high pitch of perfection. Cylinder-machines for six, eight, or ten colours are now made; but it is not general to exceed four or five cylinders.

Having thus noticed the mechanical arrangements for calico-printing, we must next speak of the substances employed as colouring agents.

Dye-stuffs, capable alone of imparting fast colours to calico, are conveniently called substantive; and such as require the intervention of a mordant, adjective. Indigo, catechu, and certain metallic oxides, belong to the former class; madder, cochineal, and Persian berries, to the latter. There are five general styles of work in calico-printing:—

1. The fast-colour or chintz style, in which the mordants are applied to the white cloth, and the colours of the design are afterwards developed in the dye-bath.

2. Where the whole surface receives a uniform tint from one colouring matter, and figures of other colours are afterwards brought up by chemical discharges and re-actions. This is called the Rongeant style in France.

3. Where the white surface is impressed with figures in a resist paste, and is afterwards subjected to a general dye, such as the indigo-vat.

4. Steam-colours, in which a mixture of the mordants and dye-extracts is applied to the cloth, and the chemical combination is effected by the agency of steam.

5. Spirit-colours, consisting of mixtures of dye-extracts with nitro-muriate of tin. These cannot be exposed to a steam heat without corroding the cloth. This style is brilliant, but fugitive.

The nature and operation of mordants need to be well understood. There are only three bases which are of much importance as mordants—clay, iron, and tin. The first is commonly employed in the state called acetate of alumina; the second, acetate of iron; and the third, nitromuriate and oxymuriate, or perchloride, of tin. The clay mordant is prepared by the makers of wood-vinegar, who decompose alum by acetate of lime, both being in a state of solution; it is called red liquor because it is the mordant for reds in calico-printing. The iron mordant is made by exposing iron turnings to the action of crude vinegar. The tin mordants are prepared by the ordinary chemical means, which we need not here describe. For the most delicate purposes, the acetate of alumina is prepared according to the following French prescription:—

50	gallons	of boiling water
50	pounds	of alum
20	„	of soda crystals
37½	„	of acetate of lead.

The alum is to be dissolved by pouring the water upon it in a tub, and stirring with a rake; and the soda crystals are to be added gradually to that solution. When the effervescence is over, the acetate of lead, well pulverised, is to be strewed in at once, and stirred about till it disappears by decomposition. A deposit of sulphate of lead is formed at the bottom. Acetate of alumina, mixed with a certain portion of alum, is contained in the supernatant liquor. To form an acetate of alumina free from alum, 82 parts of acetate of lead, instead of 37½, should be employed for 50 of alum. About one-half of the alum therefore remains undecomposed in the above operation. For certain purposes a formula is prescribed in which 50 lbs. of acetate of lead are used to 50 of alum. The clay mordant is used also for particular styles in a state of combination with potash. It is prepared from a solution of 100 lbs. of potash and 80 lbs. of quick-lime with 100 gallons of water, boiled together for an hour. After the calcareous matter is settled, the clear liquor is to be drawn off and boiled down to specific gravity 1·320. In 30 gallons of this lye, 100 lbs. of pulverised alum are to be dissolved at a boiling heat. On cooling, crystals of sulphate of potash form. The supernatant liquors being decanted, and the crystals slightly washed with water, about 33 gallons of mordant will be obtained.

The tint or shade of colour produced in the dyeing-bath is proportional to the strength of the mordant previously applied to the cloth. Hence by diluting the mordant to various degrees any desired shade may be obtained—as by mixing the red liquor and the iron liquor any shade intermediate between red and black is producible in the madder-bath. When the iron liquor is diluted, various shades of violet result from the same dye. Too much of this aluminous mordant should not be prepared at a time, as it is injured by keeping, in consequence of its letting fall subsulphate of alumina.

The thickening of mordants is one of the most important operations in calico-printing; for the permanence and beauty of the impression depend not a little on the consistence and quality of the inspissating substance. Several circumstances require the consistence to be modified; such as the nature of the mordant, and its density or acidity. A strong and acidulous mordant does not thicken well with starch; it requires British gum or gum Senegal. Some other mordants inspissated by starch, which have a tendency to liquify after some days, are also liable to run during the printing; this inconvenience the French printers are accustomed to counteract by the addition of 2 oz. of alcohol to a gallon of the mixture—a remedy which cannot be economically practised in this country, owing to the excessively high duties on spirit of wine. The same mordant, when thickened in different degrees, gives different shades in the dyeing; for instance, one thickened with starch gives a deeper shade than when thickened with gum. Yet there are many cases where the latter merits a preference, because it imparts more transparency to the colours, whereas a portion of starch often remains in the cloth along with the mordant after the rinsing operation. In general, however,

to obtain a like consistence, much more gum is required than starch, and thus the former not only dilutes the mordant too much, but by letting it dry too quickly prevents its forming an intimate combination with the stuff. Hence the tints are thin and scratchy. The substances usually employed for thickening are the following: flour starch, flour, roasted starch, gum Senegal, gum tragacanth, salep, pipe-clay mixed with gum Senegal, sulphate of lead and gum, sugar, treacle, glue. It is found desirable, after thickening with gum, not to add any metallic salts in a liquid state, such as nitrate of iron, solutions of tin, copper, subacetate of lead, &c.; for they have the property of coagulating gum. The thickening material should, in fact, be skilfully adapted to each particular colour.

In the colour-house there ought to be ready prepared a variety of dye-decoctions, concentrated to a proper degree either by steam boilers, or by liquid baths of regulated temperature. When evaporated over a naked fire their tint is too often degenerated. The following prescription may serve as an example: Take 5 lbs. of Brazil wood or peach wood, boil it for an hour in 10 quarts of water, and strain; boil the residuum in the same quantity of water for half an hour, and again strain; finally boil it a third time, and mix the whole strained liquors together. Evaporate the whole till it is reduced to 10 quarts. Add as much red mordant (acetate of alumina or nitromuriate of tin) to the liquor as will brighten its tint to the desired degree, and thicken it with British gum. The older the decoction, the more beautiful will the colour be. The decoctions usually kept ready are those of logwood, Brazil wood, peach wood, Persian berries, quercitron, galls, fustic, archill, cochineal, ammoniacal cochineal, and catechu.

The printing shops ought to be kept always at a pretty high temperature, from 65° to 75° Fahrenheit; with an atmosphere rather numid than dry. It is often observed that goods printed the same day and with the same mordant exhibit inequalities in their tints; being sometimes strong and well brought out in one part, flat and meagre in another. The latter portion has been printed in too dry an atmosphere, an accident more liable to happen with cylinder goods than others on account of the small quantity of colouring matter which they receive. The nearer the mordant is to a neutral state, the less likely is this inconvenience to ensue. In the padding process, as it is called, where the cloth is uniformly imbued with the mordant, the stove-room, where a great many pieces are dried at the same time, ought to have a free issue for the watery and acetic acid exhalations. The goods ought likewise to be properly extended before they are dried; for without this precaution the acetic acid would accumulate in the folds, and prevent the base of the mordant from combining with the fibres of the cloth; the consequence would be white spots in all such places, which would render the print unsaleable. When a strongly acid mordant has been employed, too much pains cannot be bestowed in facilitating its escape from the hot flue through which the goods are drawn in the drying; for the acetic fumes are capable of affecting the surface to such a degree as to cause a white down to appear upon the cloth after it is dyed. Fans will be found very useful in such cases to blow away the acidulous vapours.

After these general remarks we proceed to describe the processes of each of the five styles of printing above enumerated; and as the whole operation furnishes one of the most striking and beautiful examples of the application of chemical science to the manufacturing arts, we shall endeavour to convey some idea of the chemical constitution of the substances employed, and of the relation which they bear to the fibres of the textile material.

First style.—Chintz or fast-colours. Much of the printing done in this way is called the madder style. The following topical colours belong to this head: 1. *Black.*—It consists of 2 quarts of iron liquor, sp. grav. 1·040, thickened with 4½ oz. of starch and 4½ of flour; the starch being first rubbed up with a little of the liquor, then mixed with the flour. The old liquor being added, the mixture must be boiled over a brisk fire to form the paste, care being taken meanwhile to stir, so as to prevent its being burned by sticking to the bottom. The colour is to be poured into an earthen pot, over half an ounce of olive oil, and the two are to be thoroughly incorporated. 2. *Red.*—Take 2 quarts of red liquor, at sp. grav. 1·033, 8 oz. of starch, and tinge with a little Brazil wood. Boil for five or six minutes, and pour into a pipkin, stirring all the while. Different shades of red are obtained by preparing mordants of different strengths from the above, thickened either with raw or roasted starch. 3. *Dark Puce.*—Take 1 quart of red liquor, and 1 quart of iron liquor; mix and thicken like black, No. 1. By varying the proportions of the two liquors any brown tint may be obtained. When British gum is employed to thicken reds, 1¾ lb. of it are required for every two quarts of the liquor; in which case no other tingeing substance is needed. 4. *Violets.*—Take 2 quarts of iron liquor of sp. grav. 1·007, thicken with starch, and tinge with a little logwood. These four mordants, for four colours, are sometimes applied at once; but where brilliant reds and rose-colours are wanted, the dark colours must be inserted separately, after the bright ones are raised, by a subsequent process called grounding (filling up the ground of the figures) in this country, and *rentrures* (re-entering additional colours) in France.

The cotton goods, after having been printed with one or other of these mordants, either by the block or the cylinder method, must be hung up in a warm chamber for thirty-six hours at least before having their colours brought up in the dye-house.

The dyeing may be divided into four operations. 1. The dunging; 2. the maddering; 3. clearing the madder-grounds; 4. grounding with topical dyes.

1. The dunging is undoubtedly one of the most important though mysterious processes in calico-printing; and too much pains cannot be bestowed upon it, since it determines in a great measure the success of the madder-dyes. Its objects are to effect the complete combination of the subsalts with the cloth, and to separate the acetic acid which had not been dissipated in the stove-room; to dissolve and separate from the cloth a portion of the substances used for the thickening, and to wash away at the same time the mordants mechanically retained by the paste; and lastly, to prevent the uncombined parts of the mordants, as well as the acetic acid, with which the bath becomes eventually charged, from re-acting upon the part of the mordant combined with the cloth, or from attaching itself to the white ground. Cow-dung, the kind employed, affords to chemical analysis the following constituents: an animalised fibrous substance, to the amount of ten per cent.; albumen; animal mucus; a substance resembling bile; several salts, of which the principal are muriate of soda and of ammonia, acetate of ammonia, and phosphate of lime; benzoin, or musk, which gives it a peculiar flavour. Among all these ingredients the fibrous matter plays the principal part in the dunging of prints, from its great affinity for the alumina and the oxide of iron; it seizes them the moment they are diffused in the bath, and thereby prevents their being deposited upon the parts of the cloth which should remain white. The chalk occasionally added to the dung bath serves to neutralise the acids as they are evolved from the mordants; a little carbonate of soda is used in preference by some printers. For delicate pinks, pale yellows, and cochineal lilacs, a bran-bath answers better than one of dung. The dung-bath cistern is usually made of an oblong rectangular form, three or four feet wide, four or five feet deep, and twelve or fifteen feet long. Cast iron is usually employed for the cisterns in this country, and wood on the continent. It has one range of rollers level with the surface of the liquor, and another range near the bottom, over and under which rollers the expanded cloth is slowly passed in a serpentine course, so as to ensure the thorough operation of the liquid upon it. The rollers revolve by mechanical power, the extreme one being double, and placed above the cistern like a calender to draw the cloth (which is in webs stitched together) continuously through the baths by means of a cord tied to its end. One pail of dung is diffused through fifty or sixty pails of water. The bath must be replenished with dung from time to time, as it gets exhausted by the passage of the mordanted goods. The temperature of the bath should be maintained at about 150° Fahr. by means of a steam-pipe entering at the bottom. The duration of dunging is different for different goods, from fifteen to twenty minutes being the average time, which is regulated by the speed of the discharging calender rollers. Too high a temperature and too much dung are injurious to delicate colours, such as the pinks and the yellows; but colours thickened with starch require a higher temperature than those thickened with gum. The piece should never be allowed to stop for a moment in its progress through the bath; for the part in contact with the surface of the water would run, and cause a line mark across the cloth.

The goods must be washed in the dash-wheel, or run through a rinsing trough, and then winched through a fresh dung-cistern (commonly called a dung-copper) at a lower degree of heat than the former, and then washed again.

2. Next comes the maddering process. Madder always contains a free acid, which is more abundant in some species of the root than in others; that grown in calcareous soils often contains so much chalk as to be sufficient for neutralising the acid in the bath. The other species requires the addition of a little chalk or carbonate of soda; but care must be taken not to add an excess, for that would degrade the colour. Madder is the only dye-stuff which can saturate mordants so completely as to permit the goods to be subjected to other dyeing-baths, such as yellows, olives, &c., without losing its brilliancy by these fresh operations. Black, red, and chocolate are dyed with madder and sumach, but purple with madder alone. Different quantities of madder are used, according to circumstances, from 1 lb. to 3½ lbs. per piece of twenty-one yards; the sumach being one-eighth of the madder. The goods are entered into the automatic-reel bath when the copper is cool, the heat being brought up by slow degrees by means of internal steam-pipes, or an external fire, during the course of two or three hours, till ebullition begins. The boiling is continued sometimes for a quarter of an hour. The goods are all the time kept in a state of constant motion, down through the liquid bath on one side, up through the air and incumbent steam, and down into the bath through the other side, there being an open frame of wooden spars between them and the two sides of the copper. They are then washed and boiled in bran and water for ten or fifteen minutes; indeed if they have much white they must be branned a second time or even a third time, to clear the ground, and must be washed between each branning operation. The whitening is completed by spreading the goods upon the grass for a few days, or by passing them over a self-acting winch-reel, through a weak solution of chloride of lime. For strong reds a second maddering is sometimes given. In all these dyeing operations

too great a length of cloth should never be winched over one reel, for it would be left too long in the bath, and might get spotted or stained. The modern automatic coppers are of an oblong shape, semi-cylindrical at bottom; and the revolving axis which runs along their top is mounted with eight or ten reels, each of which winches only a few pieces tacked together into an endless web.

3. Clearing the madder-ground. Reds and pinks are brightened by being winched for half an hour through a soap-bath, at 150° Fahr., containing three-quarters of a pound per piece. They are then washed in clear water. At other times they are passed for a quarter of an hour through a bath containing a little of the solution of nitromuriate of tin; and are then soaped and rinsed, and laid out upon the grass; or cleared, as in France for fine colours, with a weak solution of chloride of soda.

4. Grounding with topical dyes. The grounding colours, or topical dyes, employed after the maddering, are chiefly blues; one, called pencil blue, may be thus made. To 2 quarts of water heated to 145° Fahr. put 8 oz. of indigo, 8 oz. of orpiment, each in powder, and 8 oz. of quicklime. Heat the mixture up to the boiling point; withdraw the vessel from the fire, and when its contents are lukewarm, add 6 oz. of subcarbonate of soda (dry); stir the whole ingredients well together, and let them settle for twenty-four hours. The clear liquor being decanted off, is to be thickened with one pound of gum for each two quarts of it in measure. This colour was formerly introduced by the pencil, and hence the name usually given to it; it is now applied by one of the rollers of the calico-printing press. Twenty-four hours after receiving this impression, the cloth must be rinsed in running water. Another pencil-blue may be made as follows:—Take 2 quarts of caustic soda-lye, sp. grav. 1·160, heated to 145° Fahr., add 12 oz. of hydrate of protoxide of tin, and 8 oz. of ground indigo; heat the mixture till it boils, removing or applying the heat twice or thrice. Lastly, let it cool, and thicken with 3 lbs. of raw sugar. The application of this colour requires very nice management. Dry fine sand is sometimes dusted over the piece as soon as it is printed, to prevent the colour from running. If these blues be not skilfully and rapidly introduced, the tints are liable to differ in different parts of the cloth. An excellent blue for printing with the cylinder is thus made:—14 quarts of caustic-lye are mixed with 3½ lbs. of indigo and 5 lbs. of hydrate of protoxide of tin. Boil the mixture for ten minutes; take it off the fire; add 3 lbs. of Venice turpentine, and then thicken with 11 lbs. of pulverised gum. Print on this colour; let it dry for two days; wash in the dash-wheel; and pass the goods through a soap-bath, containing a little soda to brighten the blue, and take off its grey tint. The turpentine serves to obstruct the contact of air in the pot with the deoxidised indigo, which would spoil it as a dye before application. To produce a topical Prussian blue dye, the following directions are given:—Diffuse through 2 quarts of water 8 oz. of starch; boil, and pour into a pipkin. Take 2½ oz. of Prussian blue, grind it up with 3 oz. of muriatic acid, and after twenty-four hours dilute with 2 oz. of water. Mix this preparation with the above starch-paste while it is warm. When the mixture is cold, add to it 4 oz. of oxymuriate of tin, and pass the whole through a sieve. Goods grounded with this colour must be passed merely through the rinsing trough. Although blue is the principal, it is not the only grounding topical dye. Topical yellows are prepared from Persian berries, quercitron, and bi-chromate of potash; orange from the sub-chromate of lead; green from nitrate of lead, bi-chromate of potash, Prussian blue, and nitrate of zinc.

For bark-yellows, the same mordant is used as for madder-reds. The piece, when slightly dunged, is winched in the quercitron-bath, heated gradually up to from 130° to 140° Fahr. during about an hour. A gold colour is given in the following way:—Dissolve 5 lbs. of sulphate of iron, and 1½ lb. of acetate of lead, in a gallon of water; mix well, and after the precipitated sulphate of lead has subsided properly, decant the clear liquor, thicken it with gum, and apply the paste by the block or cylinder to the cloth; expose to the air for eight or ten days; and then winch it through a solution of potash thickened a little with lime. Whenever the black oxide of iron first precipitated upon the cloth begins to turn red, the piece must be removed into a rinsing cistern and well washed. Yellows are however now given very generally with chrome. For this purpose the following prescription will serve:—Thicken 2 quarts of water with 6 oz. of starch, pour the paste into a pipkin and add to it immediately 4 oz. of acetate of lead, and 4 oz. of nitrate of lead, both in powder; mix the ingredients well, and leave the mixture to settle and cool, colouring it with a few drops of solution of chromate of potash. Print on this paste with the cylinder or the block, and pass the goods through a roller dyeing-bath containing bi-chromate of potash dissolved in the proportion of 2 oz. per piece; having first charged the cistern with a solution containing half a pound in solution. Then pass them first between the rinsing-rollers, and finally through a very dilute muriatic acid to clear up the ground.

Green printing with chrome may be performed as follows:—Mix 2 quarts of caustic soda-lye at 1·160 sp. gr. with 3 oz. of ground indigo and 10 oz of hydrated protoxide of tin. Heat the mixture to the boiling point, withdraw it from the fire, and when lukewarm add, by slow degrees, a solution of 1 lb. of acetate of lead in half a pound of acetic acid of sp. grav. 1·050. When the effervescence ceases, thicken it with 20 oz. of gum and 20 oz. of roasted starch. Pass the mixture through a very fine sieve. After this paste is applied by the cylinder or block, the goods must be passed through milk of lime for ten minutes; then plunged for an hour in running water, and well rinsed. They must next be passed through a solution of bi-chromate of potash, then rinsed, and finally passed through weak acetic acid to clear the grounds. They may now be dried and prepared for the market. This colour requires for its perfection, that the goods be not passed through the bath in too dry a state, because the colour would be apt to scale off. Before passing them through the padding machine therefore, they should be hung up for an hour in a humid atmosphere.

Madder purple is obtained by the application of the acetate of iron mordant allowed to act upon the goods hung up in the air for six or eight days; and after dunging, and passing them through the madder-bath, then branning and clearing.

Cochineal pink is communicated by applying the aluminous mordant, with the precautions above prescribed, and raising the colour in a bath containing about an ounce of cochineal for every piece of cloth. Cochineal has a feeble affinity for cotton, and neither needs nor admits any other process for clearing the ground except simple washing in water.

Manganese brown is thus produced:—A solution of sulphate or muriate of manganese, properly thickened, being printed on, the calico is to be dried, and passed through a powerful caustic lye; from which it must drop into a solution of chloride of lime. The manganese is thereby raised to a higher state of oxidisement, in which it exercises a pretty strong affinity for cotton. In France a little tartaric acid is added to the solution of muriate of manganese before thickening it with gum, of which one pound and a-quarter are used for 2 quarts of the liquid, at a sp. gr. of 1·075.

Catechu brown, called carmelite by the French, is managed as follows:—In one gallon of water boil 1 lb. of powdered catechu till the liquor is reduced to half its bulk; pass it through a very fine sieve: dissolve in the filtered liquor 4 oz. of verdigris, and let the solution cool. Thicken with 5 oz. of starch, and while still tepid dissolve in it 5 oz. of powdered sal ammoniac. Print this dye on the goods, and after a few days pass through the rinsing apparatus.

Second style.—We now pass to the second style of calico-printing, the *Rongeant* style of the French; in which the whole surface of the cloth receives a uniform tint from one colouring matter; after which, figures of other colours are produced by chemical discharges and re-actions. The chemical action of the discharges must here be understood. Some of them are simple; some mordanted.

The elegant style of simple and mordanted discharges of Turkey red cloth was invented many years ago by MM. Kœchlin, of Mühlhausen, and introduced into this country by Mr. Thomson, of Primrose, near Clitheroe. An excellent white discharge paste is made by the following prescription:—Dissolve in 2 quarts of water three-quarters of a pound of oxalic acid and 1½ lb. of tartaric acid, and add to the solution 2 quarts of lime juice concentrated to sp. gr. 1·230. Thicken with 6 lbs. of pipe-clay and 3 lbs. of gum. This is to be applied with the block or the cylinder-machine. The piece, after being dried, is passed through a bath containing a solution of chloride of lime. A cistern of wood, frequently lined either with zinc or lead, about five feet square and six feet deep, is furnished with a square wooden frame-work, bearing a series of parallel rollers in two ranges from top to bottom; which frame may be let down into the cistern, and lifted out at pleasure by the help of a pulley and counterpoised cord. The cistern is to be filled with a solution of chloride of lime, having a specific gravity of 1·040, and a proper decolouring force by the indigo test. Before entering the goods, the bath should be stirred up a little. The calico-pieces, stitched together lengthwise, are now by means of a guiding-cord led serpent-like over the respective rollers in horizontal planes, and are drawn through by a pair of squeezing-rollers at the opposite side to that where they entered. The cloth should be exposed to the action of the chloride liquor during a space of three minutes, by the equable motion of the drawing-rollers; and on its escape from them should be allowed to fall into a cistern of water, or be passed through the rinsing apparatus. Common madder reds and pinks are discharged in another way. The goods are passed through the acetate of alumina liquor in the trough of the padding-machine, called *foulard* by the French, whereby they are prepared for the madder-bath. They are dried, and then impressed with the discharge paste by means of the engraved block or cylinder. This paste consists of concentrated lime-juice properly thickened with pipe-clay and gum. Sometimes a little tartaric acid is added, or even bi-sulphate of potash, for the sake of economy. This mordant is also sometimes applied before passing the cloth through the padding-machine; a practice supposed to produce the clearest whites, as the mordant in this case is never suffered to attach itself to the places intended to be white. If cloth so treated be subjected to dyeing in the madder-copper, its ground will come out red; if in the madder and logwood-copper, it will come out reddish brown; if in the cochineal, it will come out a beautiful pink; and in the logwood alone, a chocolate; with logwood and galls, black. If, after applying the above discharge paste by the block or cylinder, the

goods be padded with iron liquor or a mixture of iron and aluminous liquor, on dyeing them up in the madders, or other coppers, prints with various dark grounds will be obtained, enlivened by white figures. The best discharges upon manganese or bronze grounds consist of the acidulous nitromuriatic solution of tin, or salt of tin. To 2 quarts of water, made into a paste with 9 oz. of wheaten flour, add, when cold, from half a pound to a pound of muriate of tin crystals, according to the depth of the manganese tint to be discharged.

Compound discharges not only remove the mordant from the ground wherever they are applied, but introduce a new mordant upon the discharged points, so as to lay the foundation for these points receiving peculiar colours in the subsequent dyeing or padding operations. When mordanted goods are intended for the discharge process, they should not be much exposed to the air, as the mordant becomes thereby of too fixed a nature to be completely removed. Nor should they be washed out before the piece receives the discharge; for it ought to be kept in mind, that passing the goods through either the dung-bath or even chalk and water, tends to fix the mordant too firmly for the perfect action of the discharge. After receiving the discharge paste from the block or cylinder, the goods should be hung up in a cool place; for if suspended in a hot chamber the effect of the discharge will be impaired. After exposure for about twenty-four hours, more or less, according to the nature of the discharge, they must be subjected, at the rinsing-roller machine, to water heated to about 140° Fahr., and mixed with a little chalk or carbonate of soda, just enough to saturate the acidulous washings. They are then washed in cold water, next dunged, and finally dyed up in the proper copper.

A violet ground, with red and white figures, may be thus produced: —Pad with very weak iron liquor; dry moderately; print on the cloth with the one cylinder of the two-colour machine the red liquor mordant, properly acidulated with concentrated lime juice of specific gravity 1·240, and with the other cylinder the discharge-paste strengthened with tartaric and oxalic acids. After drying, rinse the goods through chalky water; dung, and dye in the madder-copper, and clear them as already prescribed.

To produce a gray ground with pink figures, the gray is first given with decoction of galls and nitrate of iron, applied the one after the other. The discharge paste is made by thickening 2 quarts of a strong decoction of Brazil wood or peach wood with 9 oz. of flour, and adding to the paste when cold 10 oz. of solution of tin, made by dissolving salt (muriate) of tin in twice its weight of muriatic acid.

To produce a chrome-yellow discharge upon a Turkey-red ground, take 2 quarts of lime-juice of specific gravity 1·09; dissolve in it 2 lbs. of tartaric acid, 2 lbs. of nitrate of lead; thicken with 2 lbs. of pipe-clay and 1½ lb. of gum, each previously pulverised. Tinge the mixture with a little chromate of potash, to indicate its nature. Most mordants are faintly coloured for that purpose. After applying this paste as above prescribed for the white discharge, pass the goods through the bath of chloride of lime, and rinse; then pad with bi-chromate of potash, which converts into a brilliant yellow all the figures to which the discharge-paste has been applied. For a green discharge upon Turkey-red ground; to the discharge for chrome-yellow add 12 oz. of Prussian blue colour, prepared by mixing 5 lbs. of Prussian blue in powder with 6 lbs. of muriatic acid, and diluting the mixture after twenty-four hours' digestion with 4 lbs. of water. Bi-chromate of potash may be employed as a discharge. After having dyed the goods in the indigo vat, they are to be padded in a bath of bi-chromate of potash, containing from 1 to 1½ oz. of the crystals per quart, according to the depth of blue to be discharged. Dry in the shade without heat, and print on the following discharge:—dissolve in 2 quarts of water 1 lb. of oxalic acid, 8 oz. of tartaric acid, and thicken the solution with 3 lbs. of pipe-clay and 1½ lb. of gum, adding to the whole 4 oz. of muriatic acid. After this paste is printed on, the goods must be rinsed through chalky water, heated to 145° Fahr., then washed in clear water and passed through very dilute sulphuric acid. The bi-chromate acts here a similar part to chloride of lime; for wherever the roller applies the acidulous paste there is an immediate white discharge, with the disengagement of a peculiar odour.

Third Style.—We now pass to that style of printing in which the white surface is impressed with figures in a resist paste, and is afterwards subjected to a general dye, such as that of the indigo-vat.

The name of resist paste is given in England, and that of reserve in France, to the substances which possess the property of counteracting the indigo-vat dye, in the spots to which they are applied to cloth. They have been divided into four classes: those of a fatty nature; those with a basis of metallic salts; the coloured reserves, capable of communicating different colours in the course of their application; and lastly, mordant reserves, which form the lapis lazuli style. The first are used only in silk-printing.

To prepare a white resist for deep blue, to be applied by the cylinder:—Dissolve in 3 quarts of water 1¼ lb. of acetate of copper in crystals, and 5 lbs. of sulphate of copper, adding thereafter 3 lbs. of acetate of lead; thicken with 5 lbs. of gum, and add to the whole 5 lbs. of sulphate of lead. Print on with this paste; hang up for two days, and dip during two hours, by repeated immersions, in the blue-vat. Finally, pass through very dilute sulphuric acid, to clear up the white figures. For a chrome-yellow resist:—Dissolve in 2 quarts of water 1½ lb. of nitrate of lead, half a pound of the acetate of copper; add to the solution one pint, or nearly so, of a saturated solution of subacetate of lead; thicken with 1½ lb. of gum and 3 lbs. of pipe-clay. Triturate the whole together, and pass through a sieve. After printing on this resist paste, the goods must be hung up for two days, and then dipped in the proper blue-vat. Steep the goods in water for half an hour, then rinse out slightly, and pass through a trough containing twelve pailsful of tepid water holding half a pound of soda crystals in solution. Turn over for a quarter of an hour, and rinse again. Now pass the goods for half an hour through a solution of bi-chromate of potash, containing 5 oz. for every piece; rinse; and, in order to separate the paste, pass through muriatic acid largely diluted with water, till the yellow hue comes fully out. Wash and dry.

In the lapis lazuli style, a resist for a full-bodied red is thus produced:—Dissolve in 2 quarts of red liquor, specific gravity 1·09, 2 oz. of corrosive sublimate, and thicken with 2 lbs. of pipe-clay and 1 lb. of gum, adding 4 oz. of olive oil. This and other coloured reserves are to be printed upon the cloth with the three or four-coloured calico-machine; four days thereafter give the pieces, at different periods of ten minutes each, successive dips in the blue-vat of the desired hue, with alternate exposure of them in the air also of ten minutes, according to the blue tint in demand. Rinse in a stream of water for half an hour. Into a copper nearly filled with water put two pailsful of bran; make the contents boil; then add cold water to lower the temperature to 180° Fahr. Enter the goods, and winch them during twenty minutes in the bran-liquor; remove and rinse them; pass them next through a trough containing sixteen gallons of water acidulated with three quarts of vinegar, and thereafter wash to prepare for the maddering, which is to be done with the precautions already prescribed, taking care not to raise the heat of the madder-copper above 190° Fahr. The lapis style of goods must be finished with a bath of bran and exposure on the grass, twice or oftener alternated if necessary, to bring out the lustre of the colours. A little soap-water aids in the brightening.

Though China blues differ in their principle of application, they may be considered most conveniently under this head. The blue colour is prepared by grinding 16 lbs. of indigo, 3¾ lbs. of orpiment, 22 lbs. of copperas, with 5½ gallons of water, in the common indigo mill during three days. A part of this paste is to be thickened with strong gum-water in successive degrees of dilution, and a part of it preserved unmixed. Take three different shades of blue, the darkest being thickened with starch, and the pale with gum, and apply them by the cylinders of the three-colour machine. Hang up the pieces for two days in an airy place, not too dry, and then proceed to dip them as follows: three cisterns must be charged; the first with 300 lbs. of lime for 600 pails of water; the second with a solution of sulphate of iron (green copperas), at a density of 1·048; the third with a solution of caustic soda lye, at a density of 1·055, prepared from soda crystals and quicklime with water. The pieces being stretched on the frames, are to be dipped into the vat No. 1, and left there for ten minutes; they are then withdrawn, and allowed to drip during five minutes. They are now dipped in vat No. 2, for ten minutes, and taken out to drip for five minutes. After the last dip, the frame with the piece upon it must be immersed in a fourth vat, charged with sulphuric acid of specific gravity 1·027. The object of this immersion is to remove the oxide of iron deposited upon the surface of the cloth in its successive passages through the lime and copperas vats. It is next exposed for an hour to a stream of water, and finished by the action of a tepid bath of sulphuric acid, of specific gravity 1·027. The blues are afterwards enlivened by a feeble soap bath, at a heat of 145° Fahr. The theory of Chinese blues is one of the most beautiful developments of modern chemistry. The indigo and sulphate of iron imprinted at first on the cloth exercise no action upon each other till the cloth is plunged into the lime-water vat. Here a portion of the sulphate of iron is decomposed, and its protoxide is rendered free to de-oxidise the indigo, and to render it soluble in the lime-water. In this dissolved state its particles can penetrate the textile tissue, combine with its filaments, and on exposure to the air become a fixed insoluble blue. On dipping the cloth into the second copperas vat a new layer of oxide of iron is formed on the whole of its surface, which oxide operates only on the indigo spots, de-oxidising another portion of the indigo, which becoming soluble is removed at the second dip into the lime-vat. By these alternations, successive deposits of oxide of iron and sulphate of lime ensue, for the separation of which from the cloth the frame needs to be agitated in the lime-vat. In the copperas-vat, on the contrary, the frame should be kept motionless, to favour the deposition of as much oxide of iron as possible upon the indigo points. From these circumstances we may account for the accidents which frequently befall the China blue process in unskilful hands. The blues sometimes scale off, from the paste being dried too hard before the goods are dipped. When the temperature of the vat-liquors is too low, the blues get a gray tint, and are always dull.

Fourth style.—Steam colours; in which a mixture of mordants and dye-extracts is applied to the cloth, and the chemical combination is effected by the agency of steam. This modern style combines with the beauty of colour such a degree of solidity as can be obtained only

by the madder copper. An example will illustrate the mode of procedure. The goods are to be padded in the following mordant at a specific gravity of 1·047. In 30 gallons of boiling water dissolve 30 lbs. of alum, 5 lbs. of dry carbonate of soda, and 15 lbs. of acetate of lead. After mixture and subsidence, draw off the supernatant acetate of alumina. After being padded, the goods are to be dried over the hot flue, and, after being hung up three days, they are to be washed in chalky water at 133° Fahr., then rinsed in clear water and dried. The goods should be smoothed by the calender before being printed. A mordant for steam-colour may be thus prepared Dissolve in 7 gallons of boiling water 10 lbs. of alum, 5 lbs. of acetate of lead, and 20 oz. of sal ammoniac. Let the mixture settle; decant the supernatant liquor, of specific gravity 1·075; and thicken with gum. Black figures are given by printing-on the following paste. In two quarts of strong decoction of logwood, thickened with 8 oz. of starch, dissolve, while tepid, 2 oz. of sulphate of iron. Pour into a pipkin containing 1 oz. of olive oil; stir, and when it is cold, add 4 oz. of nitrate of iron containing a little acetate.

Other colours are produced as follows. For a full-bodied red, thicken 2 quarts of a strong decoction of peach-wood by boiling 8 oz. of starch in it; when cold, add 12 oz. of solution of nitro-muriate of tin. For a steam-blue with Prussiate of iron; dissolve in one quart of water 3 oz. of oxalic acid, or 3½ oz. of tartaric; and in another quart dissolve 6 oz. of prussiate of potash; mix these two solutions, let them settle during twenty-four hours, decant the clear supernatant liquor, and thicken it with 1¼ lb. of gum. A steam-green paste is prepared by adding to the preceding blue a strong decoction of Persian berries, mixed with the above aluminous mordant containing sal ammoniac, and thickened; the proportions of the yellow and blue pastes determine the shade of green. The supernatant liquid of the blue formula contains ferrocyanic acid, convertible, by the steam-heat and the agency of the vegetable acid, into Prussian blue, which fixes on the cloths. For producing lemon-yellow; take 2 quarts of a decoction of Persian berries, made from 2 lbs. of berries, 2 quarts of the above mordant with sal ammoniac, thickened with 3 lbs. of gum.

The goods, after having one or more of these or other such colours printed on them with the cylinder machine, should be suspended for two days in a chamber of a temperature not exceeding 88° Fahr. The colours are afterwards raised and fixed by the application of dry steam; for any aqueous condensation will spoil the prints. There are five kinds of apparatus for applying steam in steam-colour printing:—the column or cylinder; the lantern; the cask; the steam-chest: and the chamber. We shall content ourselves with describing the column, as it is most generally used in this country. It is a hollow cylinder of copper from two to six inches in diameter, and about forty-five inches in length, perforated along its whole surface with small holes about one-sixteenth of an inch in diameter, and one quarter of an inch apart. To the lower end of the cylinder a circular plate is soldered of about nine inches diameter, which serves to prevent the cloth coiled round the cylinder from falling down from it. The bottom of the hollow cylinder is terminated by a tube one inch wide, which fits tight into the socket of an iron chest beneath it, into whose side the steam-pipe of supply enters. The water condensed from the steam is also received into that chest, and may be run off by means of a stop-cock near its bottom. In some cylinders the steam is admitted at the top, and the condensed water is allowed to run off by a small siphon tube at the bottom. The goods printed with the above steam-colours and properly dried are lapped tight round this hollow cylinder and covered exteriorly with an envelope of strong cotton cloth, blanket-stuff, or flannel. The steam is then let on, and continued for twenty or thirty minutes, according to the nature of the dyes. The steam being stopped, the printed goods are rapidly unrolled from the column while still hot, lest any condensation of vapour should take place to stain them.

Fifth Style.—Spirit colours. These are brilliant, but fugitive; they consist generally of decoctions of dye-woods, mixed with nitromuriate or muriate of tin. The following red will serve as an example. Thicken two quarts of decoction of peach wood with four ounces of starch; dissolve in the paste while hot four ounces of alum; add to the mixture when cold four ounces of oxymuriate (perchloride) of tin, and two drachms of sulphate of copper. This and similar colours are applied by the two, three, or four-coloured printing-machine, and passed through a drying room slightly heated. The goods are next tenderly rinsed in running water: afterwards washed, and dried quickly, but with a moderate heat.

The above are the general principles and processes of calico-printing. We shall now treat briefly of two or three collateral matters.

It would scarcely be possible, if necessary, to notice all the patented improvements in calico-printing, introduced within the last few years. Nor would it, indeed, be desirable; for however they may differ in detail, the leading principles remain nearly unaltered. A clever chemist—and there are now clever chemists in all the print-works of any note—will devise a new mordant for a particular colour, or a new drug for a particular dye; he may find new modes of conducting the many remarkable processes incidental to the printing; the skilled machinists of Lancashire and Glasgow may invent new forms of machinery; and artistic designers may throw new beauty into the designs and patterns selected; but there are certain general points of

resemblance in all these arrangements. There is one novelty, however, which we must notice, as it drew forth an honorary medal from the Society of Arts. The Society offered a premium in 1853 for "Improvements in machinery for printing calico and other fabrics, by which ten or more different colours may be worked simultaneously, and with accurate register." The motive for this offer was, to produce if possible as delicate printing by the machine as by the block method. "Of late years, cylinder machines for printing cheap cotton and other fabrics have attracted much attention, to the neglect of the ordinary block machines, which are known to produce a superior article in point of softness and artistic effect." Mr. Dalton, of the Hollingworth calico print works, near Mottram, thereupon sent a paper and a model to the Society, which gained for him a silver medal, as one who had responded to the invitation sent out by the Society. He had long known the inefficiency of the iron cylinders, with their folds of lapping and their endless webs, as ordinarily used. "It is of primary importance to the attainment of a perfect impression from the engraved rollers on the cloth, that the surface of such medium should be perfectly smooth and even, and should also possess sufficient softness and elasticity to enable the cloth to take up the colour from the depressed lines of the engraving, without being in itself permanently indented or marked by the pressure. It is a matter of extreme difficulty to obtain these desiderata by the usual mechanical arrangement. Numerous inequalities in the texture, and slight variations in thickness, exist in the newest webs; and after being a short time subjected to the abrasive action of the machinery, accumulations of woollen particles, termed in the trade 'flocking.' This unevenness of surface necessarily occasions a corresponding variation in the depth of shade produced by the impression, and an omission altogether of the finer lines of the pattern." This led Mr. Dalton to the use of an impression-cylinder covered with an inch and a-half of gutta percha, and so arranged as to work without lapping or webbing. This cylinder he calls a *bowl*, but it will be more familiar to ordinary readers to call it a *roller*. He employs two wholly distinct forms of apparatus for applying the rollers. *First method.*—Having prepared a gutta-percha roller, solid, elastic, smooth, and even, suitable for producing a uniformity and regularity of impression, a saving of power and an economy both of material and of labour, he surrounds it with ten engraved cylinders (supposing there to be ten colours in the design). The cylinders are pressed against the gutta-percha rollers by screws and springs, each having its colour-box and its spreaders. The different parts of the machine being properly adjusted, the calico is brought into contact with the roller, clings to its surface, and travels on as it revolves, receiving as it goes the pressure of the first engraved cylinder. The elastic surface of the roller gives way to the pressure sufficiently to enable the depressed lines of the engraving to imprint the colours on the cloth without any consequent depression remaining on the roller. The cloth travels on around the roller, receiving an impression from each cylinder in turn, all falling precisely in register, or on the proper places. *Second method.*—This differs very materially from the former. The machinery is in three sections, each with three gutta-percha rollers. The two outer rollers of each section are pressed upon the engraved cylinder by weights and levers; the central one is pressed by springs and screws. The engraved copper cylinders are placed at equal distances horizontally, in such way that the pressure from each roller is received by the two cylinders revolving in contact with it. Thus the first and last cylinders receive the pressure of one roller only each; whereas all the others receive the pressure of two rollers. The calico, unwinding from its roll, travels to the first roller, where it receives the impression of colour from the first cylinder; passing on with the revolution of the roller, it receives an impression of another colour from the second cylinder; moving with this second cylinder, a second impression is given to it by the second roller—thus receiving what is technically called two "nips" by each cylinder, except the first and the last. The advantage sought for by this "nip" is to bring out the impression more fully and forcibly on the fabric; and in case the pressure of the first roller should chance to be ineffective, the omission will be rectified on its coming into contact with the second roller. Thus the calico traverses the whole machine, receiving ten colours one after another in its passage. In the ordinary method of cylinder calico-printing, the pressure is made by each engraved cylinder against the blanketed cylinder; but in Mr. Dalton's method, the gutta-percha presses against the engraved cylinder; by which any casual variation or inequality on the surface of the cloth will merely affect the pressure roller, without producing any injury.

The establishments in which calico-printing is conducted are among the most interesting of our scenes of industry. In those belonging to the leading manufacturers there is always a chemical department, comprising not only a store of all kinds of drugs and dyes required, but every requisite for making experiments on the almost numberless mordants, baths, pigments, oils, acids, alkalies, &c.; retorts, sand-baths, furnaces, stills, steam-heaters, mixing vessels, crushing and grinding apparatus, all are here to be seen. Then there is the artistic department, in which the important matters of design and pattern are treated; if it be an establishment (there are such) in which the owners do not scruple to appropriate the patterns of another firm, the artistic department is little other than a place where stolen goods may be sophisticated to escape detection; but in the honestly

conducted print-works, designers are well paid to produce novel and beautiful patterns. Then there is the engraving department, where the designs are transferred to wood blocks, metal plates, or metal cylinders, according to the kind of work to be done. Out of a hundred designs made on paper there may be eighty rejected as inappropriate; and out of the remaining twenty engraved, there may not be more than two or three which possess the double excellence of being practicable to work and attractive in their tasteful appearance. Under any circumstances, the expense of these drawings and engravings is enormous; but on the other hand, a thoroughly successful pattern sometimes proves a fortune to its owners. Among the other departments of such establishments is the "cloth room," where the calico or muslin is thoroughly examined before printing; the "block-printing rooms" and "cylinder-printing rooms," in which processes are carried on indicated by those names; mangling-rooms, starching-rooms, drying-rooms, examining-rooms, packing-rooms, &c.; besides all the engineering workshops and apparatus necessary for the daily repair of a large assemblage of machinery. Some of the cylinder-machines will print calico at the rate of *a mile an hour* each; and it is in this way that the productive powers of such establishments become so enormous.

We shall now briefly notice the legislative arrangements relating to the management of print-works.

When the first "Factories' Act" passed, limiting and contracting the power of employing children in factories, many members of both Houses of Parliament wished its provisions to apply to calico print-works, as well as to spinning and weaving mills; but this was not acceded to. The subject was, however, afterwards taken up with great earnestness; and in 1845 Lord Ashley (the present Earl of Shaftesbury) brought in a Bill for extending the Factories' Act to print-works, with certain modifications depending on the exigencies of the trade. Commissioners, appointed in 1840 to investigate this and collateral matters, said in their report, in reference to print-works:—"In Lancashire, Cheshire, and Derbyshire, instances occur in which children begin work in this employment at as early as between four and five, and several between five and six inclusive; many begin between six and seven, and the great majority between eight and nine. Out of 565 children taken indiscriminately from returns obtained for each section of this district, it appears that one child began work between four and five; 3 between five and six; 68 between six and seven; 133 between seven and eight; 156 between eight and nine; 127 between nine and ten; 49 between ten and eleven; 26 between eleven and twelve; and 2 between twelve and thirteen. In the east of Scotland children commence work at the same early ages." The Commissioners moreover found that these children worked in rooms at a temperature varying from 65° to 110° Fahr., the latter being sometimes the degree of heat in the stove-rooms, where the goods are placed to dry. Some of the children occasionally fainted under the influence of this tremendous heat; those engaged near the dash-wheels had their feet and dresses saturated with wet. The hours of labour, too, were very great for such young persons; nominally, they were twelve per day, but really they averaged fourteen or fifteen; and in busy times there was scarcely any other limit than that which human strength could bear. Health was affected; education was neglected; morals deteriorated. Basing his reasonings on the facts stated in this report and on subsequent inquiries, Lord Ashley drew up his Bill. Sir James Graham, on the part of the Government, without opposing the measure, pointed out the necessity of caution in dealing with such a subject, lest, in protecting the children, we should paralyse the trade itself. He urged, that the work of children is absolutely necessary; that print-works are not, in general, unhealthy places; and that, as there are periods of great demand alternating with very slack seasons in that trade, any fixed arrangement of hours might be disastrous. Nearly 25,000 children were supposed to be employed in the print-works of the United Kingdom; and it became, therefore, a grave question how far, and in what way, to interfere in this peculiar department of industry. Between the periods of the first and second reading of the Bill, Sir James Graham, as Home Secretary, caused all the inspectors of factories to examine the Bill with the light of their own personal experience, and to attend to such objections as the master-printers might urge against it. The result of these inquiries was, to induce the Government to assent to the Bill in a modified form. Lord Ashley had proposed that its provisions should apply to bleach-works, dye-works, and calendering-works, as well as to print-works; but Sir James Graham would only agree to the last-named application. He agreed to prohibit the employment of children under a certain specified age, and to prohibit night-work by children; but in neither direction would he go so far as the Bill proposed. Lord Ashley was very unwilling to modify his measure; but he accepted the Government offer as a means of securing the passing of a Bill, which would at any rate be a movement in the wished-for direction, and which would not preclude further measures of a similar kind in subsequent sessions. Receiving certain amendments in both houses, it passed into law, and became the Act, 8 & 9 Vict. c. 29.

Of this Statute we give a brief outline. The Act came into operation on the 1st of January, 1846. To define the terms used, "child" is declared to mean a person under thirteen years of age; "young person," between thirteen and sixteen; "a day," from six in the morning till ten in the evening; "night," from ten in the evening till six in the morning. The inspectors of factories to be inspectors of print-works under this Act. Inspectors empowered to enter any print-work, and examine into all matters connected with the employment of children and young persons therein. No children or young persons to be employed without a certificate from a surgeon, countersigned by a magistrate. No child to be employed under eight years of age, and no child or young person at night. A certain amount of schooling prescribed for every child and young person, and the schoolmaster to be controlled in certain matters by the inspectors. A good clock, a register of attendance, a copy of the Act, and a set of printed rules, to be kept in each print-work. Finally, the Statute laid down the requisite means for enforcing obedience to its provisions.

Calico print-works have ever since remained under the influence of this Statute, subject to only minor alterations. It has been shown, under BLEACHING, that bleach and dye-works have not yet been brought under the regulations which apply to cotton-mills and print-works, although many attempts have been made in that direction.

Concerning the extent of the trade in printed calicoes and muslins, very little of a precise kind can now be stated; for the home consumption is not interfered with, or registered by, any legislative enactment. Something on this subject will be found under COTTON TRADE AND CONSUMPTION. In the present place we will merely state the quantity of printed and dyed calicoes exported within the last few years. This does not mark the full extent of the export trade; for there is another (but very small) entry, under the confused heading of "Cambrics and muslins, plain and printed or dyed," in the Board of Trade tables; this entry is so small in amount that we may disregard it.

1849	530	millions of	yards.
1850	576	„	„
1851	569	„	„
1852	564	„	„
1853	651	„	„
1854	584	„	„
1855	687	„	„
1856	803	„	„
1857	808	„	„
1858	786	„	„

The quantities are here given in round numbers, sufficiently near for the purpose. The marked extension of the trade in the last three years will not fail to be observed.

CA'LIPH, CA'LIPHAT. Caliph, properly *Khaleefeh*, is an Arabic word, which primarily denotes a successor or vicar, and was at first given to the sovereigns of the Muslim Arabs, as signifying successor to the Prophet; but is generally used in a more limited sense, as the title of certain dynasties of Mohammedan sovereigns. It was first adopted by Abu Bekr, the immediate successor of Mohammed, and, together with *Emîr-al-Mûmenîn*, "the commander of the faithful," continued for several centuries to be the title of the principal line of Mohammedan sovereigns. The word Caliphat (Arabic, *Khaleefat*) is used both as a general designation of the line of sovereigns called caliphs, and, in a geographical sense, for the extent of countries subject to their dominion. The principal of these caliphats were Spain, Africa, Egypt, and Bagdad.

CALIPPIC PERIOD. [CALIPPUS, in BIOG. DIV.]

CALLIOPE. [MUSES.]

CALLIPERS. [COMPASSES.]

CALLUTANNIC ACID. [TANNIC ACIDS.]

CALMS (at sea) occur at certain seasons in every part of the ocean, except perhaps the parts near the poles; but they seem to increase in frequency and duration as we approach the equator, and in the immediate vicinity of the equator there is an immense extent of sea, in which they are so prevalent that it has been called the *region of calms*. The calms, however, do not always occupy the same portion of the ocean, but they vary according to the position of the sun. When the sun is in the northern hemisphere, they are sometimes found to extend as far as 15° N. lat., and then the S.-E. trade-wind passes four or five, or even six degrees to the N. of the equator. When the sun is in the southern hemisphere, the calms also occur to the N. of the equator, but they come very near to it and sometimes reach it, whilst their northern border extends to 60° or 70° N. lat. Thus it appears that this region of calms does not extend on both sides of the equator, but is entirely in the N. hemisphere, which arises from the circumstance that, on account of the unequal distribution of land and water in the two hemispheres, the terrestrial equator is not the line of greatest heat. In some seasons the calms extend over eight or even nine degrees of latitude; at others over a smaller space, and sometimes only over two and a half or three degrees. The average breadth of the region of calms is about six degrees. These remarks refer to the Atlantic Ocean. In the Pacific an equatorial belt of about five degrees in breadth, of such habitual calm as to have given that name to the ocean itself, lies between the north-eastern and south-eastern trade-winds. This is a belt of constant precipitation of the aqueous constituent of the atmosphere. Captain Wilkes, of the American Exploring Expedition, when he crossed it in 1838, found it to extend from 4° to 12° N. He was ten days in crossing it; and during those ten days rain fell to the depth of 6·15 inches, or at

the rate of eighteen feet and upwards during the year. For about sixty degrees of W. latitude, from 120° to 180°, this belt, according to Lieut. Maury, is in the southern hemisphere, its northern edge coinciding very nearly with the equator; this southerly depression of the region is probably occasioned by the great extent of open sea in the Pacific. In the colloquial language of seamen the equatorial calms are designated the *Doldrums*.

In the Atlantic region of calms known as the *Variables*, which separates the N.-E. and S.-E. trade-winds,—being produced by their neutralisation of each other, a neutralisation so complete that far at sea a candle burns without flickering,—the calms do not continue without interruption. Sometimes light breezes blow, especially from the S. and S.S.W. Besides this the calms are commonly interrupted every day by a wind which lasts a quarter of an hour or twenty minutes. After noon a black and well-defined cloud is formed near the E. horizon, which seems to announce a violent thunderstorm. The cloud increases, a wind suddenly rises, and blows with great violence for a few minutes. It is accompanied by a few drops of rain, but in a few minutes the rain ceases, the air reassumes its clearness, and the calm returns. These daily squalls, though of short duration, enable the navigator to pass the region of calms, which even with this aid always proves very disagreeable. Violent thunderstorms, however, frequently actually occur. These calms, united to the immense quantity of fucus or gulf-weed which is found W. of the Cape Verde Islands, may have given rise to the opinion of the ancients that the sea near the equator grows shallow, and becomes a swamp unsuited for navigation.

Parallel, in each hemisphere, to the equatorial belt of calms, are the "horse latitudes" of seamen, which are zones of calms bordering, respectively, the north-east trade-winds on the north, and the south-east on the south, which also follow the declination of the sun; along the polar border of each is another region of precipitation, though the rains are generally less constant than in the equatorial calms.

(Horsburgh, *India Directory*; Rennell's *Invest.*; Humboldt; Mrs. Somerville's *Physical Geography*; Maury's *Physical Geography of the Sea*).

To witness and examine the actual phenomena of contact of the winds blowing from opposite or different quarters, where the neutralisation, or production of calm, begins, must always be difficult; partly from our ignorance of the precise locality, and often from its inaccessibility when known. In the case of the trade-winds alluded to in this article, it must begin in variable planes, perpendicular or inclined to the horizon. But of the phenomena attending the production of a calm region at a great elevation, by the neutralisation by each other of the north-east trade-wind, and the south-west wind above it, in planes approximately horizontal, we have some particulars in Professor C. Piazzi Smyth's 'Report of the Teneriffe Astronomical Experiment of 1856,' pp. 480, 481. At the observing station of Mount Guajara, on the Peak, the altitude of which was 8903 feet, in July and August, he observed that the tops of the lower hills of the island, at about the level of the trade-wind cloud, or 4000 feet, were swept by the wind with terrific force; "but above that height," he states, "the wind, still preserving the same N.-E. direction, continually decreases in strength, until it reaches a neutral stratum below the S.-W. wind, which appears there to be always the direction of the upper current in the atmosphere, in the summer at least, for which season alone my descriptions are intended to apply. The height of this neutral region would seem to vary much; sometimes it was below, but much more generally above 9000 feet. Hence we had more N.-E. wind than S.-W. at Guajara; but being in the neighbourhood of the neutral stratum, neither wind was felt in great force, except on one occasion, when for several hours in the evening the N.-E. wind blew with a velocity of from twenty to thirty miles per hour." At his second station of "Alta Vista," at the height of 10,700 feet, there was on the whole less wind than at Guajara, and it was more evenly balanced between the two directions. In his work entitled 'Teneriffe, an Astronomer's Experiment,' p. 382, Prof. Smyth adds, that on September 19th, when he left the mountain, from the upper station "the N.-E. trade, the characteristic of a Canarian summer, was gone, and the S.-W. wind, though blowing on the mountain-top, had not yet descended to take possession for the winter of those lower zones; where a meteorologic interregnum was in consequence evidently prevailing. The air, however, was exquisitely transparent." [WINDS, TRADE.]

CALMUCKS, or KALMUCKS, is the name given by the Russians to one of the principal branches of that division of the Mongols which bears the general name of Olöth, or Oïrat. This nation is more widely dispersed over the globe than any other uncivilised people, the Arabs not excepted. Calmuck tribes occur over all the countries of Upper Asia between 38° and 52° N. lat., and from the most northern bend of the Hoang-ho to the banks of the Volga. We are acquainted with four principal branches. The Olöth inhabited chiefly the centre of these countries, to the south and north of the Thian-Shan range, in the present Chinese government of Ili, whence they extended their conquests over the neighbouring tribes during the 17th century, and founded an empire of great extent and power, which was destroyed by the Chinese emperor Kang-hi in 1698. Upon this event, the name of Olöth merged in that of Zoongars, another numerous nation of the same origin, which inhabited the adjacent countries. The Zoongars also were for a short time formidable to the neighbouring tribes, especially the Khalkas, or proper Mongols: their empire was destroyed by the Chinese in 1757. By these continual and unsuccessful wars both nations have nearly been annihilated, and their names have almost disappeared. The Turbut, or Derbet, forming the third principal branch, had long before these events submitted to the Chinese emperors; and, united with the remnant of the Zoongars, they still inhabit the countries about the lake of Koo-koo-nor, and along the Hoang-ho river, where it forms its great northern bend. They are considered and treated by the Chinese rather as allies than as subjects. A few also joined themselves to the Toorgoots.

The fourth branch of the Olöth, which received the name of Calmucks from the Russians, is properly called Toorgoot, and inhabited the countries west of those of the proper Olöth. But during the continual wars which they had to wage with these more powerful neighbours, they began to extend their excursions towards the west, and at last settled, with the permission of the Russians, in the steppes which extend between the Volga and the Ural, in 1672. There they remained nearly a century; but in 1771, after having repeatedly been invited by the Chinese to return to their native country, the greatest part of them suddenly left the Russian territories, and returned, by a march of eight months, to the banks of the river Ili, where the countries whose inhabitants had been destroyed in the wars between the Chinese and Zoongars were assigned to them by the Chinese. Their number was estimated at 50,000 families, or 300,000 souls. The smaller portion of the nation, estimated at 12,000 families, remained in Russia, and their descendants yet inhabit the country betwixt the Don, the Volga, and the Kuma.

In the form of their body the Calmucks resemble the Mongols, and the languages of the two nations differ perhaps not more than the Italian and the Spanish; but the proper Mongols have a rich literature, while that of the Calmucks seems to be limited to a few compositions or translations respecting the tenets of Buddhism, a religion which has been embraced by all the nations of Mongol origin.

The Calmucks have no fixed abodes, but movable huts, called kybitkas, which they carry from one place to another, in order to be always near the best pasture for their herds. They live entirely upon animal food, and do not cultivate the ground. They have large numbers of camels, horses, and sheep, but not many cattle. Their horses are of a middling size, very strong and swift. Their sheep are of the same kind as those of the Khirgis, with large tails and good wool, of which the women make different stuffs for dresses, blankets, coverings for the kybitkas, &c.

They are not the immediate subjects of the princes in whose countries they live, but have their own hereditary chiefs, and an hereditary nobility, to whom they are much attached, and to whom they pay strict obedience. Their military or marauding excursions, to which they are much inclined, owing to their wandering habits of life, make them very troublesome to their neighbours.

CALOMEL. [MERCURY, CHLORIDE OF.]

CALORIC. [HEAT.]

CALORIC ENGINE. In the article AIR ENGINE an account was given of certain contrivances intended to have the power of steam-engines without the use of steam. Most of the machines there noticed require the action of air, wholly or in part heated; but a reference was made to the present article for a brief account of certain air-engines which have acquired some notoriety under the name of *caloric engines*.

The theory of caloric engines is by new means a new one. Besides the inventions of Stirling, Von Rathen, and Randolph, described in the article just quoted, there have been many others depending on an analogous principle. Sir George Cayley made many attempts in this direction. In 1827 Messrs. Parkinson and Crossley followed in the same track. Mr. Parsey has made many experiments, and taken out more than one patent, for hot-air engines. One of his patents, under date 1854, comprised the employment of an improved pump, for compressing or exhausting air; an aërometer or movable reservoir for storing air, and giving it out again under pressure; and a mode of heating the working cylinder of an engine. Mr. Shaw, an American inventor, has brought forward some contrivances intended (or hoped) to obtain more power from air than from steam. His engine comprises an oscillating horizontal cylinder, an air-compressing chamber, heating tubes, and various other adjuncts. The heat and smoke from a furnace are made to give up a portion of their caloric to air contained within certain tubes. An air-pump forces air from the atmosphere into a compresser, where it is maintained at 60 lb. on the square inch, and whence it passes into the tubes. There are many other parts of the apparatus, all contributing to the main purpose of moving a piston in a cylinder, thereby giving rotatory motion to a shaft. But there remains the objection so fatal to all such engines—that air requires the same amount of power to compress it as is obtained afterwards from the same air in the compressed state. Among all these inventors, however, the one who has bestowed the largest amount of attention on caloric engines is Captain Ericsson, to whose contrivances we shall at once proceed.

Ericsson's inventions, some patented and others not, have been brought before public attention during about a quarter of a century, his

first patent being dated 1833. The boldness of his theory, in reference to the powers ascribed to his caloric engine, attracted much attention a few years ago; for it went to the length of asserting that hot air, when brought into contact with an extensive surface of iron wire gauze, is deprived of its heat; that this heat may be the next moment imparted to an incoming current of cold air; that these duplicate processes may take place over and over again; that fuel will be required only for the *first* action, with a little surplus for radiation; and that thus an engine might be worked continuously with scarcely any continuous expenditure for coal. Captain Ericsson seems to have modified his views at different times; but in 1854 he undoubtedly believed that *the same portion* of heat can be made to produce mechanical power over and over again. In a lecture at Boston (U.S.) in that year, by an advocate of Ericsson's views, the lecturer said: "The object of Ericsson's caloric engine is the production of mechanical power by the agency of heat, at an expenditure of fuel so exceedingly small that man will have an almost unlimited mechanical force at his command, in regions where fuel may now be said hardly to exist. The announcement of such an idea may startle all those acquainted with the nature of heat, and the well-known limits to the amount of mechanical power which any given quantity of caloric is capable of producing. . . . . Ericsson's theory of heat is altogether in opposition to the received notion that the mechanical force produced will bear a direct known proportion to the quantity of caloric generated. . . . . The basis of the caloric engine is that of returning the heat, at each stroke of the piston, and using it over and over again. . . . . This result Captain Ericsson has accomplished by means of an apparatus which he styles a *regenerator;* and so perfectly does it operate, that the heat employed in first setting the engine in motion continues to sustain it in full working force, with no other renewal or addition than may be requisite to supply the inconsiderable loss by radiation."

Civil engineers in England and America have not been slow to predict the inevitable failure of any mechanism based on this theory. Professor Ewbank, in the 'Journal of the Franklin Institute,' has treated the Ericsson theory of heat as essentially unsound, in relation to mechanical appliances. Leaving untouched the acknowledged ingenuity displayed in the mechanism of the caloric engine, and avoiding equally the question of the absolute mechanical equivalent of a given amount of heat, he confines himself to an inquiry into the reproductive powers claimed for the new apparatus. After adverting to the fallacies of perpetual motion, and the defeat of the hopes of all who in this way have sought to create power out of nothing, he adds: "There are those who discard as absurd all attempts to gain power by wheels, springs, and levers, and yet imagine they can get it by fluids, without giving anything like the usual price for it; and so specious have these plans appeared, that both experienced and inexperienced men have been led astray." Speaking of Ericsson's invention, the professor remarks: "The principle on which his invention rests is, the repeated use of the same caloric. In this engine, as in the steam-engine, heat is the animating principle; and in using over and over the same heat, he virtually uses over and over the same power. He claims to have succeeded in seizing upwards of 90 per cent. of heat expended in raising a loaded piston, and in returning and compelling it to do the same work over again. The regenerator, though an ingenious device, is not what its name implies. It is at best but an *economiser* of heat, in the same sense and after the same manner as contrivances by which the waste steam of engines impart heat to cold water."

It would not be practicable to describe Captain Ericsson's caloric engine (or rather engines; for he has invented many, differing considerably one from another) in detail, without an absorption of greater space than the subject would justify; but an outline of the experiments made public may be given in a few words.

In the summer of 1852, two of Ericsson's caloric engines were at work in a factory at New York; and as newspaper paragraphs frequently appeared, presenting most favourable accounts of the working of these engines, arrangements were planned for building a ship of 1000 tons burden, to be propelled by hot air instead of by steam. It was anticipated that the Atlantic might be crossed by such a ship in fifteen days, and at a vastly cheaper rate than by the superb but costly Cunard steamers, thereby more than compensating for the quicker passage of the latter. The ship was 250 feet long, and had paddle-wheels 32 feet in diameter. On its first trial trip, in the early part of 1853, the ship made twelve knots an hour with the wind, and answered the helm well; she used only six tons of fuel per day, and was pronounced to be a beautiful ship, even irrespective of her caloric. Such, at least, was the account given by the inventor and proprietors; but it was remarked at the time, that disinterested persons were not afforded the means of verifying this report. On the second trial, the maximum speed attained was nine knots—obtained, as asserted, at a cost only one-sixth of that of steam. After this, unfavourable circumstances one by one came to light; and the ship, named the 'Ericsson,' in honour of the inventor, failed to establish the validity of the principle involved. Influenced by the results of further experiments made in 1854, the indefatigable inventor took out another patent in 1855, for certain novelties in the apparatus. In this new caloric engine, the heated air, after performing its duty by raising the piston in the working cylinder, is made to circulate through a vessel containing a series of tubes; and the current of heated air, in passing through this vessel or regenerator, is met by a current of cold air, circulating in an opposite direction through the series of tubes in its way to the working cylinder. Thus there is cold air within the tubes and hot air without; an interchange takes place, or rather an equalisation, by a transference of caloric from one to the other. The current of cold air, on its way to the working cylinder, after having thus been partially heated by the transference of caloric, is made to pass through a series of tubes or vessels exposed to the fire of a furnace. The action of the engine itself is what is called "differential," the motive energy depending on the difference of areas in the working and supply cylinders. The heater and regenerator are supplied with fresh compressed atmospheric air at each stroke of the engine. In the year now under notice (1855), the old caloric engine was taken out of the 'Ericsson,' and steam-engines substituted. Captain Ericsson would not admit, however, that this was an evidence of failure in his plans; he asserted the soundness of the principle, and the economy in fuel. The first engine made, was, he said, too cumbrous for the available amount of power in the ship, and the losses by leakage and friction were greater than had been anticipated. A second was made; but the joints of the pipes of the heaters were not good, and could not bear a greater pressure than such as would produce a speed of seven knots an hour. Surcharged or overheated steam was used, because the hot air escaped; and then occurred a dislocation of the whole machinery by an explosion. This accident led to the substitution of steam-boilers; but even then Ericsson would not admit that the *principle* of his caloric engine was proved to be unsound; seeing that the accident had arisen from mechanical defects, and that the change consisted only in the use of steam-boilers instead of air-heaters.

So far as concerns the principle put forth by Captain Ericsson, the results hitherto obtained justify the objections taken to it by engineers. Nevertheless, the peculiar action of the regenerator has been much admired; and if this apparatus were designated an *economiser*, instead of a regenerator, its prospective usefulness might be recognised. It is still believed by many engineers, that there are certain conditions under which hot air would be preferable to steam as a motive power. Mr. Hawkins, at the Liverpool meeting of the British Association in 1854, offered reasons for thinking that the maximum theoretical efficiency of air-engines, consistently with safety, is higher than that of steam-engines. So far as concerns Ericsson's caloric engines, some of small power, applicable to factory operations, are admitted to indicate an economy of fuel.

CALORIMETER. [HEAT.]

CALOTYPE. [PHOTOGRAPHY.]

CALOYER (*καλογερας*), the name given to the Greek monks, from kalos and geras, meaning comely, venerable old age. They are mostly of the order of St. Basilius, and inhabit convents, the principal of which are on Mount Athos. They are bound to celibacy, which is not the case with the secular clergy or papas of the Greek church. The Caloyers abstain from meat, and observe six Lents in the year, besides other fasts, at which times they abstain also from butter, eggs, and fish, and live only upon bread, vegetables, salt, and water. There are also convents of female Caloyers.

CALTROP, commonly called Chausse-trape or Crow's-foot, a piece of iron formed with four points, each about three inches long, which are so disposed, that, when the piece is thrown on the ground, one of them stands always upwards. In warfare crow's-feet are sometimes scattered about in order to impede the march of cavalry, especially in fords, &c.

CALUMET, the name given by the North American Indians to a pipe for smoking tobacco. In Harris's 'Voyages,' vol. ii., p. 908, the following description of this pipe is given: "The calumet or pipe of peace is a large tobacco pipe, with a bowl of polished marble, and a stem two feet and a half long, made of strong reed, adorned with feathers and locks of women's hair. When it is used in treaties and embassies, the Indians fill the calumet with the best tobacco, and presenting it to those with whom they have concluded any great affair, smoke out of it after them." To refuse the calumet is a sign of hostility. It is offered to strangers as a mark of hospitality. To smoke the calumet of peace literally signifies, in the language of the North American Indians, "to be on terms of friendship and alliance."

CALVINISM. [CALVIN, JOHN, in BIOG. DIV.]

CALX. [CALCINATION.]

CAMALDOLENSES, CAMALDOLITES, a religious order founded by St. Romualdo, at the beginning of the 11th century. The order was a reform of that of the Benedictines, whose constitutions St. Romualdo retained, with some modifications of additional strictness, one of which is the silence enjoined to members of the community. The dress of the Camaldolites is white, and they wear their beards long. The first establishment of the order was in the high Apennines, above the Casentino, or valley of the Upper Arno. The order of Camaldolites, like other branches of the Benedictine order, has produced many learned men.

CAMBOGE. Though this gum-resin was made known in Europe by Clusius in 1605, the tree which yields it is not accurately ascertained. All writers agree in referring it to the tribe of the Guttiferæ, and several authorities point to Stalagmites Cambogioides (Murray), which according to Wight and Arnott is a species of Garcinia (probably synonymous with Garcinia cochinchensis (Chois.), the Oxycarpus

cochinchensis of Louriero), as the source of the Siam camboge; while that of Ceylon is stated to be obtained from the Xanthochymus ovalifolius. (Roxb.) Others assign the Ceylon camboge to the Mangostana Morella. (Derous. in Lamarck, 'Encyclo.' vol. iii. p. 701.) This last point it is of less importance to settle, if the statement of Dr. Christison be correct, that Ceylon camboge is not now an article of European commerce, all that is found in the markets of this country coming from China.

From the bruised leaves and young branches of the first-mentioned tree flows a yellow juice, which is received in cocoa-nut shells or earthen vessels; it is then allowed to thicken, and afterwards formed into rolls. This is the finest sort, called the pipe camboge of Siam. A portion is formed into round cakes, which are either entire or have a hole in the centre. This is the cake camboge of Siam.

The juice from the *Xanthochymus ovalifolius* flows spontaneously, but sparingly; it is increased by incisions in the stem, and by kindling fires in the vicinity of the tree. The colour of both kinds differs according to the season of the year, the age, and part of the tree from which the juice is obtained. The Siam camboge occurs in pieces of variable size, externally of a dirty yellowish brown colour, covered with a fine yellow powder. When broken they exhibit a conchoidal or vitreous fracture, with a brown or saffron-yellow colour.

At the ordinary temperature of the air camboge has little smell, but when heated it gives out a very peculiar one. Taken into the mouth it has scarcely any perceptible taste, but upon being chewed for some time it causes a sharp, somewhat acrid feeling, ending in a sweet sensation, accompanied with dryness in the mouth. It excites afterwards a flow of saliva, which is coloured yellow. Its specific gravity is 1·207. A specimen of pipe camboge of Siam, analysed by Dr. Christison, yielded as follows:—

Pipe Camboge of Siam.		Cake Camboge of Siam.	
Resin	74·2	Resin	64·8
Arabin	21·8	Arabin	20·2
Moisture	4·8	Fecula	5·6
Woody fibre, a trace.		Lignin	5·3
		Moisture	4·1

Of Ceylon camboge one specimen yielded—

Resin	75·5
Arabin	18·3
Cerasin	0·7
Moisture	4·8

The cake camboge is not entirely a natural production, but a manufactured article.

Camboge is almost entirely soluble in alcohol, and is not precipitated from solution by the addition of water. With water it forms an emulsion in which the resin is kept suspended by the gum. It is soluble in the alkalies. The resin may be considered its active principle. It is remarkable that a substance possessed of such slight sensible qualities, having no smell, and scarcely any taste, should be so powerful in its action on the human frame. It is a drastic purgative; and in combination with alkalies, forms a most powerful hydragogue cathartic, occasioning numerous copious watery motions. In an overdose it causes excessive purging, sometimes vomiting; and if taken in large quantity, it produces inflammation of the intestines, mortification, and death.

The diseases in which it is most useful are ascites, or dropsical accumulations in the cavity of the abdomen, especially if accompanied with obstructions in the liver, or other abdominal viscera. It has also been employed against the tape-worm, and obstinate or habitual constipation. The doses must be carefully regulated, and only taken by the order of an intelligent and responsible medical attendant. Its use as a quack medicine has led in many cases to fatal results.

Yellow juices, which when inspissated form a substance resembling camboge, are obtained from several trees, both of the tribe of Guttiferæ and Hypericaceæ. Garcinia pictoria is stated by Mr. Royle ('Flora of the Himalaya,' p. 132) to yield a camboge, which in its crude and unprepared state is superior to every other kind; but it is not so permanent. The Garcinia celebica (Linn.) likewise furnishes some. Several species of Vismia (Hypericaceæ) yield an American camboge of good quality;—V. sessilifolia (Pers.), V. guianensis (Pers.), V. cayennensis (Pers.), V. micrantha (Mart.), Vismia baccifera (Mart.). The Hypericum pomiferum (Roxb.) also yields a sort of camboge; and the Argemone mexicana.

Camboge is more extensively used as a pigment than as a medicine.

An artificial camboge is manufactured with turmeric and other materials. This should always be rejected.

CAMBRIC is one of the numerous varieties of flax or linen manufactures. It is supposed to have derived its name from having been first made at Cambray. It bears much the same relation to linen that muslin does to calico, being a very fine and thin fabric. Scotch cambric, now manufactured in large quantities, is a kind of imitation cambric, made from fine hard-twisted cotton. The French material *batiste* is a sort of Scotch cambric, to which dyes and printed colours are applied.

French cambrics are imported and Scotch cambric exported to some extent, but do not figure largely in the Board of Trade returns.

CAMELLIA JAPONICA, or *Japan Rose.* The botanical description of this plant has been given in the NAT. HIST. DIV. [CAMELLIA.]

All the varieties of *Camellia Japonica* succeed best when treated as conservatory plants; that is, planted in the open border under glass, protected from frost, and freely exposed to light and air. They then grow into large evergreen bushes, covered with a dense foliage, upon which their gaudy flowers are beautifully relieved, and are far handsomer objects than when their roots are confined within the narrow compass of a garden-pot. Many of the varieties are nearly hardy, that is, they can bear the ordinary winters of England almost without protection; but then they are so very inferior to conservatory specimens, as to be little worth the having as out of door shrubs, unless upon our south-west coast, in some of the warm bays of Devonshire and Cornwall. They are multiplied by cuttings, grafts, and buds, and also by seeds; there are hundreds of varieties; the best are the double-white, the double-stripe (with the *Donkelarii*, which has a red and white stripe in a different style), the *C. myrtifolia*, *Chandlerii*, and *punctata*. They thrive best in half loam from rotted turfs, and half turfy peat, broken up very fine. After they have bloomed, or even while flowering, buds will be formed for the succeeding season. These, when forming at the top, or on long straggling branches, should be carefully pinched off, in order to induce the plant to become thick and bushy, as well as to prevent its wasting its strength; while all the buds that are well-placed should remain. After the plant has done flowering, it should be pruned of all useless or unsymmetrical branches. If they require to be shifted from one pot to a larger, this is the time for doing so. The plants may then remain in the greenhouse, where they should be secured plenty of air, but shaded from the sun during the hottest parts of the day, until they have made their growth. They should now be placed out of doors, sheltered from the mid-day sun, and guarded from high winds, until it is time to return them to the conservatory, which is about the month of September, so as to avoid the effects of the early frosts.

The *Camellia reticulata*, one of the finest species of the genus, remarkable for its net-marked leaves, and its semi-double rose-coloured flowers, can only be brought to perfection by being treated as a conservatory plant, and planted in a pit or greenhouse, in the open mould. If confined in a pot, its leaves are apt to become white and unhealthy. If placed in a bright hothouse, its leaves and flowers are rendered much deeper-coloured, but altogether smaller, and the shoots more stunted. This sort will not easily propagate, either by buds, or cuttings, or grafts, like the common camellia, but requires to have its young wood inarched upon healthy young camellia stocks, when it takes freely; but the parent plant, if many of its shoots are thus treated, suffers so much from the mutilation attendant upon the process, that it is two or three years before it is sufficiently recovered to submit again to the operation.

CAMELOPA'RDALUS, the camelopard or giraffe, a constellation formed by Hevelius. A line drawn from Capella to the pole-star passes right through the body of the constellation: the hind part precedes in right ascension, of which the whole ranges from four to eight hours. The letters are of course not in Bayer. The following are the principal stars:—

Character.	No. in Catalogue of British Association.	Magnitude.
	1058	4
	1062	4
a	1474	4
b	1504	4
β	1536	4

CAMEO, a gem or stone engraved in *rilievo;* that is, in which the object represented is raised above the plane of the ground, in contradistinction to INTAGLIO, in which the subject is incised, or indented: strictly speaking the term cameo refers to such stones only as have strata or grounds of different colours. There has been much unsatisfactory discussion respecting the origin and exact meaning of the word cameo, and Ducange, Lessing, and others have quoted various ways of writing it.

The art of engraving stones is of high antiquity: but it was at the earlier periods, for the most part confined to *intaglio*, or indenting, a simpler and an easier process than relieving the work from a ground; and as such stones were used for signets or seals in very remote ages (Exod. xxviii. 11, 21, &c.), the intaglio mode of working seems to be the most natural as well as the best adapted to the purpose. For intaglios, transparent stones of a single colour, or at most clouded stones (as the agates), were used; but for cameos, stones variegated in colour, or with colour in thin strata, as the onyxes and sardonyxes, were employed; artificial stones were also used.

It has been supposed that the Etruscans had the art of engraving hard stones before it was known to the Greeks; and from the forms resembling those of the *scarabæi* of the Egyptians, it has been thought that the Etruscans derived their knowledge from Egypt. Many engraved stones however that are called Etruscan, are doubtless early Greek, as may be inferred from their subjects, and from the occurrence in the inscriptions of characters of a Greek form.

The earliest Greek artist distinctly mentioned as an engraver of stones, is Theodorus of Samos; Herodotus (iii. 41) tells us that the famous ring of Polycrates "was the work of Theodorus, the son of

Telecles the Samian;" though some writers speak of Mnesarchus, the father of Pythagoras, as an engraver of signets. There has been much discussion respecting the age and genealogy of Theodorus of Samos, and whether there were one or two sculptors of that name; the probability is that there were two, but the date of the Theodorus referred to by Herodotus is pretty well determined by the circumstance for which the historian mentions him, Polycrates having been murdered in 522 B.C. It is not, however, in the opinion of some, absolutely clear whether Theodorus engraved the stone or merely chased the metal of the ring of Polycrates. (Müller, 'Archäol. der Kunst.,' § 97.) The first name of very great note that occurs in this branch of art is that of Pyrgoteles, who lived in the time of Alexander the Great, and who alone was permitted to engrave the portrait of Alexander. Tryphon deserves mention also in this place, being the author of a beautiful and well known cameo in the Marlborough collection, representing the marriage of Cupid and Psyche. He is supposed, on good authority, to have lived under the immediate successors of Alexander in Macedon.

The age of Augustus is remarkable for the excellence of the gem-engravers who were then living. Among these Dioscorides, or more correctly Dioscourides, held the highest rank. He seems, however, to have worked chiefly in intaglio. Some of his productions have reached our times, and prove that the estimation in which he was held was not undeserved. Dioscorides was under Augustus what Pyrgoteles had been under Alexander. From Augustus down to Marcus Aurelius there were engravers of gems, both in cameo and intaglio, of very distinguished merit. They were chiefly Grecian artists who settled in Rome. There were, however, some Roman gem-engravers who held a respectable rank, but the list is not considerable.

The Greek artists preferred representing the naked figure, and the finest works produced in Greece are seldom draped, while those executed in Rome, whether by native or by Greek artists, are for the most part clothed. Dioscorides continued to follow the taste of his own nation, and all his figures, with the exception of a Mercury, in the cabinet of France, are believed to be naked.

It is impossible to describe works of this sort, containing so much fine detail, with sufficient accuracy to convey a just idea of their merits. They must be seen and examined with care, to be properly appreciated. Celebrated cameos are preserved in most of the great museums of Europe. One of the most famous works is that known as the Gonzago cameo, which has the heads of Ptolemy II. and Arsinoë I. nearly six inches long; it is now in the possession of the Emperor of Russia. Another of the finest cameos known is the Apotheosis of Augustus, in the collection at Vienna. It represents Augustus, his wife Livia, as Rome, accompanied by her family, with Neptune and Cybele; another is of an Imperial Eagle; also a Ptolemy and Arsinoë, &c., &c. In the French collection the sardonyx of Tiberius is one of the best known: it exhibits the Apotheosis of Augustus and the princes of the house of Tiberius; a Jupiter Ægiochus is a very fine specimen: to which may be added the Apotheosis of Germanicus; and one of Agrippina and Germanicus; with others, particularly some portraits of great interest. We possess in this country some camei of first-rate excellence, but they are chiefly in private collections. Almost without exception the most famous works of this kind are remarkable for the different strata or zones of colour which they exhibit, as well as for their exquisite design and execution.

The ancients were fond of decorating their drinking-cups with precious stones and *camei*. They called such vessels 'gemmæ potariæ.' Many of them are preserved in the cabinets of the curious. They are usually of sardonyx.

The workers in cameo not only exercised their skill in the cutting or engraving, but also in so arranging their subject and the composition of its details as to make the different colours or zones of the stones answer for parts of the design; as, for example, in relieving fruit, flowers, or drapery, in colour, while the other parts, as the flesh of a portrait or figure, were left white; or cutting the subject entirely in white, and working no deeper into the stone than the first layer of colour; thus making, or rather leaving, a natural dark back-ground for the design. These irregularities or accidents, are sometimes taken advantage of so skilfully, that it is very difficult to decide whether the variety is the effect of art, or really the natural colour of the stone.

The ancients were so partial to this variously-coloured work, that they imitated the material, in glass or paste, and exquisite specimens of ancient pastes occur in the museums of this country and the continent.

At the decline of the Roman empire gem-engraving fell with the other arts, and it was not till a late period that the taste and munificence of the Florentine family of Medici caused its revival in Italy, and tempted artists to devote themselves to its practice. It was much encouraged in the 15th century. The wealthy required such works for ornamenting their dress, for inlaying and embossing vases, and similar display; and as objects in *rilievo* had a richer effect than others, cameo-collecting became a passion in Italy. Vasari and Marietti may be referred to as the historians of the Italian gem-engravers of that period: and the 15th and 16th centuries will be found to boast several very distinguished artists in this class. In the succeeding century there was a considerable falling off, but in the 18th the art again rose, and the names of some who exercised it will bear comparison with those of almost any age. The greater part of these were Italians, but two of the most celebrated were natives of Germany, and are justly entitled to particular commemoration. The works of John Pickler and Lawrence Natter challenge competition with the finest antiques. Natter has left a valuable work on his art, entitled 'De la Méthode Antique de graver en Pierres fines,' &c. Raspe's 'Catalogue of Tassie's Gems' may also be consulted with advantage by those who desire to extend their knowledge on this subject; as well as the works of Millin, 'Introduction à l'Étude des Pierres gravées;' Raoul Rochette, 'Lettre à M. Schorn;' Visconti, 'Iconographie Grecque;' 'Impronte Gemmarie dell' Instituto;' Müller, 'Archäologie der Kunst,' §§ 313—315, &c.

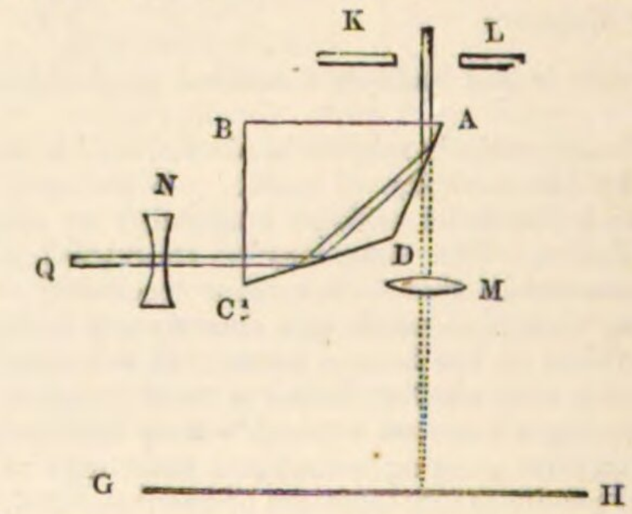
The practice of working camei on shells, *conchylie*, is of comparatively modern introduction in Italy; but it is now carried to so great an extent, in Rome particularly, and exercised with such success, that we feel fully justified in including it in our notice of the art. The subject is worked in *rilievo* in the white portion or outer crust of the shell, while the inner surface, of a pink or reddish-brown tint, is left for the ground.

The art has never been sufficiently encouraged in this country to lead any great number of artists to pursue it exclusively; but England has, notwithstanding, produced a few eminent gem-engravers, and the names of Marchant, Brown, Tassie, and Pistrucci, particularly deserve honourable mention.

CAMERA LUCIDA, an instrument used for drawing, by which the images of external objects are thrown upon a plane or curved surface. Camera lucida signifies the light chamber, though the instrument contains no chamber; but it was so called because of its bearing a certain affinity to the camera obscura, a much older instrument, and after which it was named. [CAMERA OBSCURA.]

The camera lucida is an invention of the late Dr. Wollaston. It depends upon the phenomenon [REFRACTION] that when light is attempted to be thrown into a rarer medium from a denser at more than a certain angle, depending upon the two media, none will pass through, but all will be reflected. The following is the description of Dr. Wollaston's apparatus; modifications may be found in Coddington's 'Optical Instruments' and Sir David Brewster's treatise 'On Optics.' We omit detail of fittings and adjustments.

A B C D is the section of a glass prism, having an angle A D C of 135°. This is presented to the object to be represented in such a way that



the pencils of rays proceeding from it fall on the surface C D at an angle of 45° or nearly so, and therefore by the preceding principle, are reflected on A D, and again from A D to the eye, through an opening K L, which excludes all except the end of the prism at A, and a part of the sheet of paper or other flat surface G H. Hence the image of Q is thrown towards the visible part of the paper, and the eye viewing both the image and the sheet of paper (with different parts of the pupil, however, which creates a difficulty in using this instrument) the observer is enabled to trace the object upon the paper by means of one of the following adjustments:—

1. If Q be very distant, so that the rays of the pencils are nearly parallel, those rays will emerge nearly parallel, or the image will be at about the same distance beyond G H in appearance as the object Q is beyond B C. But the image must appear to be thrown *upon* the paper, or it cannot be distinctly traced. Either therefore the image of the paper must be removed to that of the object, or that of the object must be brought up to the paper. For long-sighted people, or those who see objects best at a distance, the first is most advantageous. It is done by placing a concave glass M, the principal focus of which shall be in or near the paper. The consequence is, that the pencils from the points of the paper are rendered nearly parallel, and by an adjustment for raising or lowering the lens the image of Q may be made to appear to coincide with that of the paper. But for short-sighted persons, who require near objects or divergent rays, the end may be answered by employing, instead of the convex lens at M, a concave lens at N, which makes the rays of the image diverge, and by adjustment of which they may be brought to appear as pencils diverging from the paper. Mr. Coddington has remarked that this lens must produce an unnecessary distortion of the image, and that a short-sighted person had better use the convex lens at M, in the manner of a long-sighted person; using spectacles, or placing a concave lens at K L, to bring the images nearer, or to render the rays more divergent.

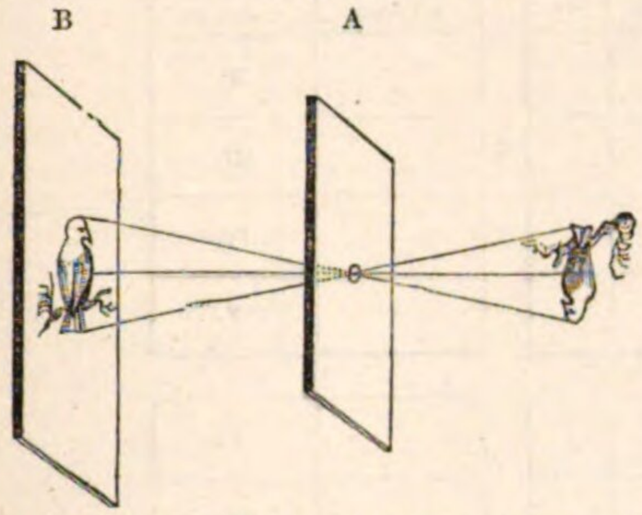
2. When the object Q is near the prism, the latter is raised or lowered on its pillar until the paper and the object are at equal or nearly equal distances from the prism. The image of Q will then be thrown on the paper without any necessity for a lens.

The camera lucida thus described presents the objects direct, and without reversal of left and right; but it is by no means an easy instrument to use. There is what is called a knack, which some can acquire, and some cannot. It has been found of considerable use by travellers who were unable to draw from nature, but it is at best little better than a toy, and thus it has been in a great measure superseded even for unartistic travellers by the photographic camera.

CAMERA OBSCURA, the dark chamber, an instrument by means of which images of external objects are thrown upon a plane surface, or, as it is termed, focussing screen.

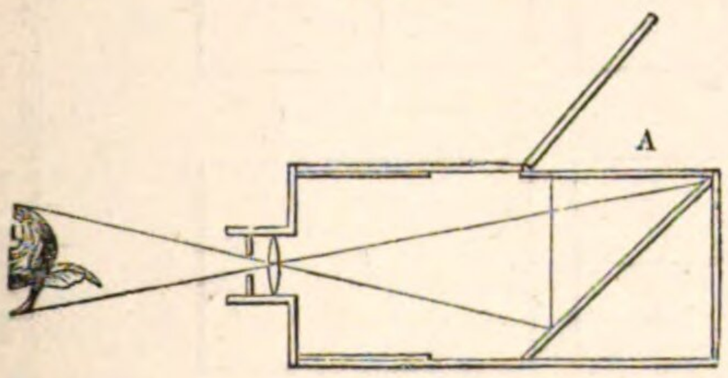
The earliest description of the camera obscura is in the seventeenth book of the 'Magia Naturalis' of John Baptista Porta, who directs to make a small aperture in the shutter of a perfectly dark room, and to let the light fall upon a white screen or wall. It is evident that in

Fig. 1.



this way inverted images will be obtained, the magnitude of which will depend upon the distance of the screen from the aperture. Porta makes one more step towards the present instrument. He states, as a secret which he had concealed till then, and had intended always to conceal, that if a convex glass be applied to the aperture, all external objects shall be seen as clearly as to a bystander, with so much pleasure that those who see it can never enough admire it. He does not appear to have found out that the screen should be curved, in order that the points of convergence of all the pencils should fall exactly upon it. The present form of the common camera obscura is as follows: The box in the diagram has a tubular lateral opening which should, if the lens be large, be partly closed by a diaphragm to

Fig. 2.



diminish the effective aperture. The rays passing through the lens from a distant object are prevented from converging by meeting a mirror inclined at 45° to the bottom of the box, and are thus made to converge at or very near to the glass plate A, one side of which is ground. A shade over the glass plate excludes direct light from falling on it. The under side of the glass plate should be curved; but, generally speaking, the aperture is so small that this is of little consequence for ordinary purposes. The tube in which the lens is placed is made to slide, so that it can be adjusted to near or distant objects. The instrument being adjusted, the landscape directly in front of the object-glass will be painted on the glass A and not inverted, but only the right side on the left, and *vice versâ*.

A camera obscura for exhibition, such as is now most commonly seen at summer watering-places, is generally made in a room with a conical roof and an aperture at the top. Above this aperture is a revolving plane mirror inclined at 45°, and reflecting pencils downwards. A convex lens causes these pencils to converge upon a surface of plaster of Paris, properly curved. The mirror revolves about a vertical axis, thus allowing all the compass-points of a landscape to be successively thrown on the surface.

On these instruments we may observe that they are *artificial eyes*. The rays are collected by a lens or prism, and are then made to paint images upon a surface, which answers to the retina. Or conversely we may say that, in the common experiment of cutting away part of the eye of a dead animal to show the images on its retina, the eye thus employed is converted into a camera obscura.

Prior to the discovery of photography, the camera obscura was only an elegant scientific toy; but the important part it was made to play in that beautiful art at once raised it to the rank of a philosophic instrument, and its adaptation to the peculiar requirements of the art has been a subject of continuous and careful investigation. In form, as in principle, the photographic camera differs little from that above described. But the only light admitted into the camera must pass through the lens, and the image, instead of being reflected by a mirror on to the horizontal ground-glass screen A, is thrown at once upon the screen itself, which is upright and corresponds to the back of the camera in *fig.* 2, or to the screen B in *fig.* 1. The screen (in photographic cameras called the focussing screen) is of ground glass, as in the ordinary camera; but in the practice of photography it is only used for ascertaining that the object is correctly placed and properly defined, when it is removed, and the prepared plate or paper substituted.

The great objects to be obtained in photographic cameras are, that the images shall be exhibited on the screen clearly and sharply defined: in their true forms and with their natural light and shade, on a flat plane, that is, and free from all aberration or distortion. In order to effect this, the nicest adjustment of lenses, prepared with the strictest accuracy, are employed. In practice, it is found that only achromatic combinations, in which the chemical and optical foci are coincident, will serve; and that for near objects, as portraits, and for objects which are situated in varying planes, as in landscapes, very different combinations must be used. For portraits, the usual combination is formed by two compound achromatic lenses, the two flint lenses being turned towards each other, and the convex side of the front combination towards the sitter. For landscapes, a meniscus lens, formed of a double convex lens of plate-glass cemented to a double concave lens of flint-glass, is employed, the concave side (which should be very slightly concave) being turned towards the interior of the camera. The varieties of lenses made by different opticians are, however, very great, but a description of them would be out of place here. Among the most successful are the orthoscopic, the Petzval, the aplanatic, &c.

The varieties of photographic cameras are even more numerous than of photographic lenses; but none of the varieties involve any material difference of principle. The most usual varieties are such as the folding, the expanding, and the adjusting camera, or some combination intended by the inventor to secure greater accuracy or portability, or to avoid some defect in cameras in ordinary use. For taking stereographs, however, and for copying photographs, prints, &c., on a larger or smaller scale, cameras of a special character are manufactured. The *Stereoscopic Camera* is, however, little more than a double camera, or two cameras combined in one (and hence sometimes called a double lens, or binocular camera) with adjustments for giving slight independent motion to each for rapidly covering the lenses, &c. The *Copying Camera* is a more complex apparatus; arrangements having to be provided for lengthening the body of the instrument before as well as behind the lens, altering the place of the lens, focussing-glass, camera-back, dark frame, diaphragms, &c., according to the size of the copy, whether the original is transparent or opaque, &c. Cameras intended for obtaining "instantaneous photographs," as well as for other special purposes, have also been manufactured, among which perhaps might be mentioned Mr. Skaife's ingenious 'pistol camera.' But for further particulars we must refer the reader to treatises on photography and to the articles LENS and PHOTOGRAPHY.

CAMERONIANS. [CAMERON, RICHARD, in BIOG. DIV.]

CAMOUFLET, or STIFLER, is a term applied in military mining to a small charge of powder, or undercharged mine, which makes little or no crater above ground, but by the concussion underground destroys a portion of the enemy's gallery and suffocates his miners.

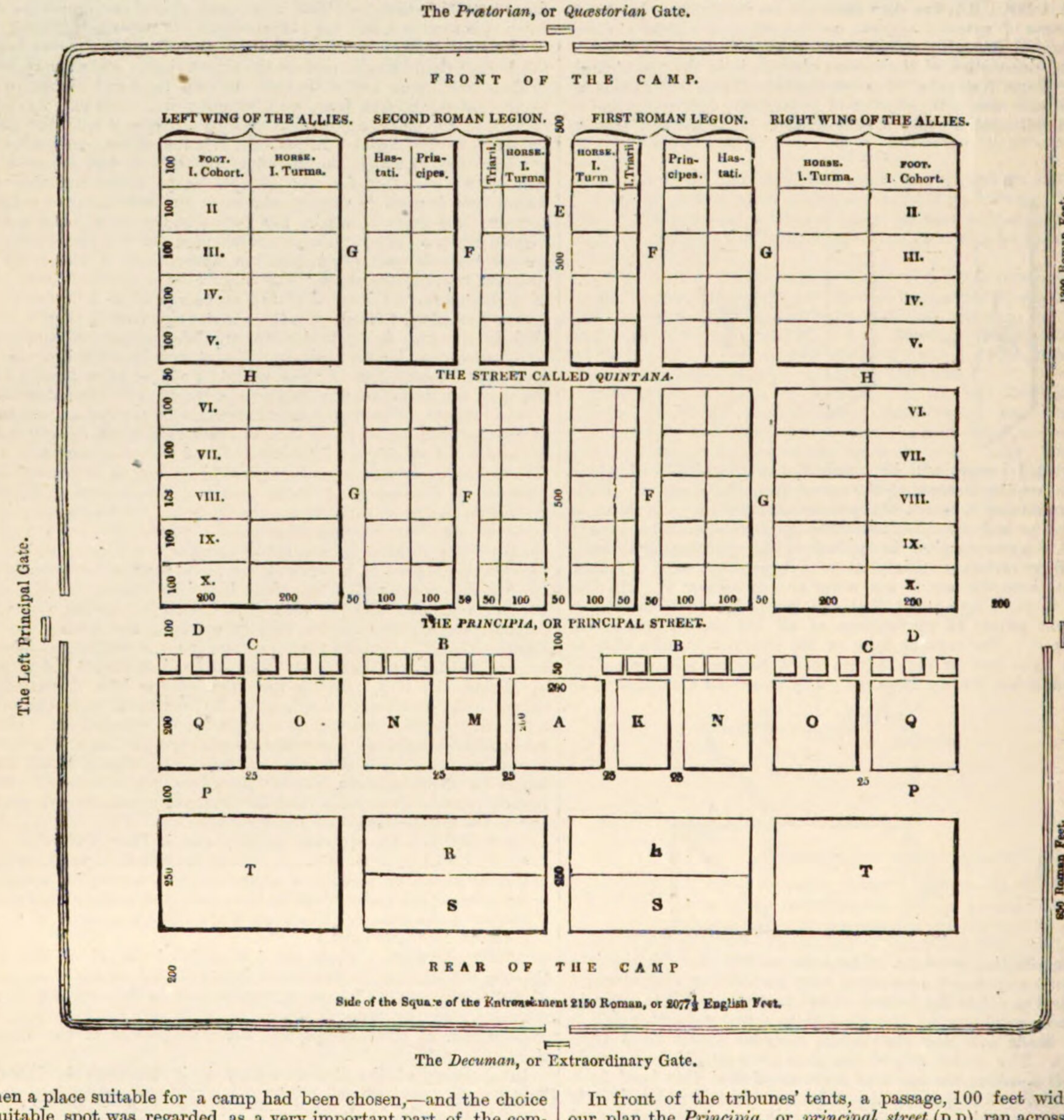
CAMP. [ENCAMPMENT.]

CAMP, ROMAN. There are few parts of the art of war as practised by the Romans in which the laborious and regulated carefulness of that sagacious people is more evident than in their system of castrametation. In the present article we shall give some account of the construction of their camps, and the arrangement of the troops in them.

In speaking of the Roman camps, it is necessary to distinguish between the summer and winter encampments (*castra æstiva et hyberna*); and again to discriminate between those camps which were formed to protect the army for a short period, and those which they proposed to occupy for a longer time, which were called *castra stativa*. The difference between these consisted chiefly in the strength of the fortifications, and in the superior size of the temporary camps, which were intended commonly for the whole army, while the more permanent encampments were for divisions of the army. Winter encampments were not used by the Romans in the earlier periods of their history, when their chief wars were little more than summer campaigns, and were waged against neighbouring nations: but in a later age, when permanent conquest was their aim, and the war continued several years, the army was regularly distributed into winter-quarters, and often spread over a considerable extent of country, in order to overawe the subjugated districts, or because forage and provisions could be obtained by the army in several divisions more easily than when it was in one body. Cæsar in his Gallic campaigns regularly distributed his army into winter-stations, so strongly fortified that though several attempts were made upon them only one was taken, and that because the commander unwisely abandoned it. (Cæs. 'De Bel. Gal.,' lib. v.)

Perhaps the completest description which we have of a Roman camp may be found in Polybius, who has in the sixth book of his history given a pretty full account of the military tactics of the Romans, part of which, relating to their castrametation, we shall condense with the further information collected by General Roy. Polybius lived at a time when the institutions of the Republic were in their full vigour; he had gained military experience in the armies of his country; and his opportunities of acquiring information, both from personal observation and from the information of others, were ample. The Roman legion, we may remark, in the time of Polybius consisted of 4200 infantry (or in time of peculiar emergency 5000 infantry) and 300 cavalry. The Consular army was formed of two legions; with a body of allied foot, equal in number to the infantry of the legions, besides the extraordinaries, chosen troops of the allies, who probably amounted to 2100, or when the legion was of 5000 infantry, to 2500; and of allied horse, thrice the number of the legionary cavalry; of these allied horse one-third were drafted for the extraordinaries, making the total of the Consular army 18,900, or 22,500 infantry and 2400 horse.

PLAN OF THE POLYBIAN CAMP OF A ROMAN CONSULAR ARMY.



When a place suitable for a camp had been chosen,—and the choice of a suitable spot was regarded as a very important part of the commander's duty,—the first thing was to fix a standard on the spot judged to be most adapted for overlooking the army when encamped, and sending commands to the different quarters. Round this standard a square of 200 feet was measured, and set apart for the general's quarters: this was called *prætorium* (A), from the name *prætor*, which, according to early Roman usage, was the general title of a military commander. On that side of this square inclosure which was deemed most suitable for obtaining forage and water, the bulk of the army was encamped, and that side of the *prætorium* and the corresponding side of the camp, we shall follow Polybius in calling 'the front.' In front then of the *prætorium*, distant from it fifty feet, on a line running across the camp, were placed the tents and baggage of the legionary tribunes (B B), who in the ordinary consular army (of two Roman legions with the regular proportion of allies, as already explained) amounted to twelve: and towards either extremity of the same line were the tents of the *præfecti* (C C) or officers, who held among the allies a rank similar to that of the tribunes in the legions. These tents were pitched with their backs to the *prætorium*.

In front of the tribunes' tents, a passage, 100 feet wide, called in our plan the *Principia*, or *principal street* (D D), ran across the camp; and between the side of this passage and a line parallel to it, near the front of the camp, the soldiers were encamped in lines, which formed a right angle with the *Principia*. The soldiers' quarters were divided into two parts by a passage 50 feet wide (E), which ran from the *prætorium* to the front of the camp. On each side of this street were posted the Roman cavalry, and next to them the *Triarii*, one of the divisions of the legionary infantry. Next to these were two passages of 50 feet wide (F F F F), and then the *Principes* and the *Hastati*, the other divisions of the Roman infantry. The tents of each division fronted the passage next to them, so that when the tents of two divisions, as of the cavalry and the *Triarii*, and of the *Principes* and the *Hastati*, were not separated by an intervening passage, they had their backs to each other. There were in a legion ten *turmæ* of the cavalry, and ten *manipuli* of each division of the infantry; and the *turmæ* and *manipuli* of each division were encamped in one range along the passages, a quadrangular space of 100 feet square being allotted to each *turma* of cavalry, and each *manipulus* of the *Principes* and *Hastati*, while each *manipulus* of the *Triarii*, which had seldom more than half the complement of the other *manipuli*, had a space of 100 feet by 50.

Beyond the tents of the *Hastati* on each side was another passage of 50 feet wide (G G G G), and then came the quarters of the allied cavalry, and beyond these again, without any separating passage, the quarters of the allied infantry, whose tents looked toward the ramparts of the sides of the camp. The tents of the allies occupied a space of the same length as that occupied by the legionary soldiers. The depth of their quarters varied with the number of the men: our plan assigns to the cavalry and infantry an equal depth, namely, of 200 feet each; this is probably near the truth. The quarters of the legionary soldiers and the allies were alike divided into two parts by a passage 50 feet wide, called *quintana* (H H), running across the camp in a direction parallel to that of the *Principia*, between the fifth and sixth manipuli and turmæ.

The space on each side of the prætorium was occupied, the one side (K) by the *quæstor* (whose office combined the direction of the commissariat department and the care of the military chest) and the military stores, and the other side (M) by the *forum*, or place for holding a market and transacting business. Next to these on each side were the quarters (N N) of the chosen troops from the extraordinary cavalry of the allies, who served in the consul's body-guard, and of the volunteers (O O) who had engaged in the service from regard to the consul. The tents of these looked towards the *quæstor's* quarters and the *forum*. Beyond these on each side, with their tents fronting the rampart of the camp, were the chosen troops (Q Q) from the 'extraordinary' infantry of the allies, who also formed part of the consul's body-guard. Behind all these, right across the camp, ran a passage or street of 100 feet wide (P P); and beyond this passage, and parallel to it, were the quarters of the main body of the 'extraordinary' cavalry of the allies (R R); and behind these, looking towards the back of the camp, were the quarters of the extraordinary foot of the allies (S S). The flanks of these quarters (T T) were occupied by any foreigners or temporary reinforcements of allied troops which might be in the camp. Polybius does not assign any particular quarters to the *velites*, or light armed men.

The space occupied by all these quarters formed a square, and on every side was left an interval of 200 feet, which served for various useful purposes, to deposit the booty, to afford space for the troops to enter and leave their respective quarters, and to protect the tents and troops from fire or weapons thrown by any who might assail the camp from without. The whole was surrounded by a rampart (*vallum*) and a ditch (*fossa*), through which were four gates or entrances: the Prætorian gate (*Porta Prætoria*), in front of the camp, opposite the *prætorium;* the Decuman gate (*Porta Decumana*), at the back of the camp; and a gate at each end of the *principia* or principal street.

If the two consular armies were united, the camp formed an oblong square, and resembled two camps placed back to back, without any intervening intrenchment. It appears to have had six gates, two prætorian and four others, one at each end of the two principal streets or passages.

The vallum was composed usually of earth or turf, sometimes of stones or wood, and was surmounted by a palisade. The ditch was on the outside. In stations which were designed to be permanent, and which were in a disturbed or hostile country, the works were constructed with unusual care, and there are many remains or vestiges of them in different parts of Great Britain. Among the most perfect are those at Ardoch, in Scotland, and Llandrindod in Wales.

The plan of a Roman camp, which we have given, is taken from General Roy's 'Military Antiquities of the Romans in Britain,' to which, and to G. F. Rettig's 'Polybii Castrorum Romanorum formæ interpretatio,' we refer the reader for many valuable observations on the castrametation of the Romans.

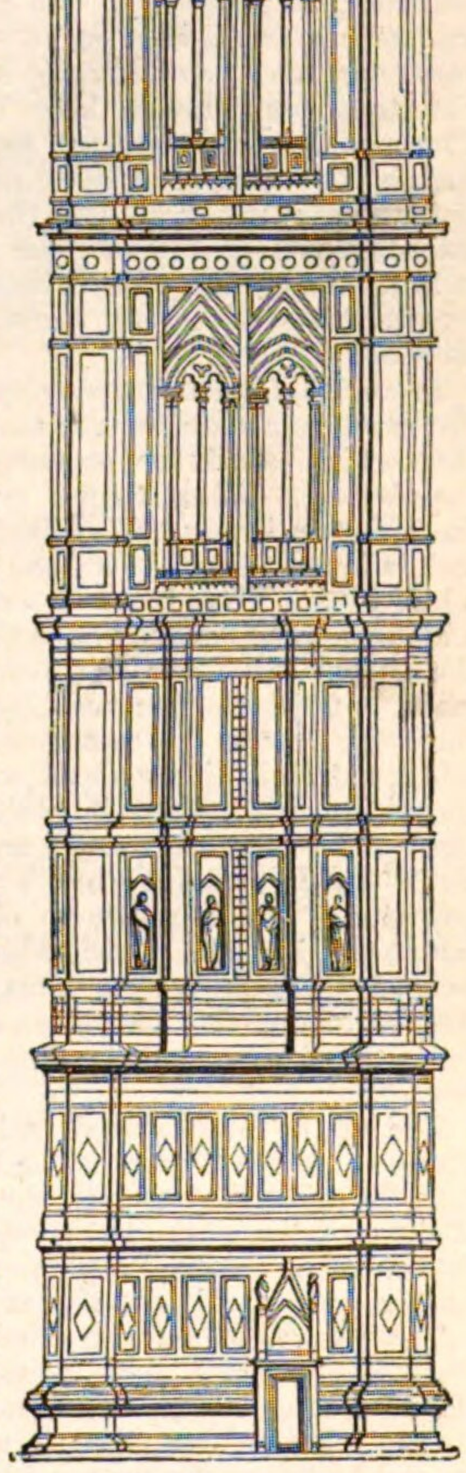
CAMP-SHEETING. An enclosure at the foot of a wall or quay, carried down to the water's edge, for the purpose of limiting the vertical compression of the ground. Camp-sheeting differs from sheet, or close, piling in this respect, that although it is executed with guide piles, whales, and sheeting, all its parts are essentially of small dimensions. It is, in fact, a diminutive sheet piling, in which the total length of the sheeting above and below ground does not exceed ten feet. Sometimes the sheeting of this description of enclosure is laid horizontally, and is spiked at the back of the guide piles which, under these circumstances, are kept very close together.

CAMPANI'LE, an Italian term, signifying a tower for bells. The word is derived from campana, "a bell." In many respects the campanile corresponds with the belfry or steeple of the Gothic churches of the North; but the term is usually and very conveniently confined to the Italian bell-towers, which differ from those of the North in being of equal dimensions from the base to the summit, constructed without buttresses, and for the most part terminated without a spire.

The campanile is essentially an Italian structure. It has no prototype in classic architecture; and, when copied even by Romanesque architects beyond the Alps, it was with a difference. Usually, the Italian campanile belongs to a church, if it does not form a part of one; but many, though attached to churches, are civic structures, as that of St. Mark at Venice, and the well-known leaning tower at Pisa; while others, like the Asinelli and Garisenda towers at Bologna, and that of the town-hall, Florence, are entirely municipal in purpose. Very frequently the campanile stands wholly detached from the church to which it belongs, but more commonly it is attached to an angle of the building. Originally the campanile was constructed with a plain solid base, pierced only with small windows for two-thirds of its height; the upper story or stories having one, two, or more, larger round-headed windows, or an open loggia. Of this kind is the campanile of St. Mark, already alluded to, which was begun in 992, and is one of the oldest campanili left; the heavy upper story is of more recent date. With the introduction of the pointed arch, more of lightness and ornament was imparted to the upper part of these structures, they were more distinctly divided into stories, and they were crowned with a cornice or surmounted with a spire; but the square form was retained, and they remained uniform in size and without buttresses. Sometimes the spires were made octagonal at the base, and much enriched in the lower part; but they seldom harmonise well with the tower, and usually they are of no great elevation, and not remarkable for elegance of outline. Among the most remarkable Italian campanili are those of Cremona, Florence, Ravenna, Padua, Modena, Mantua, Sienna, Bologna, Pavia, Verona, and Pisa.

Some of these campanili are much out of the perpendicular, especially those of Pisa and Bologna. The Garisenda, built by the Garisendi, at Bologna, is 153 feet high, and 8 feet 6 inches out of the perpendicular. Dante has compared this tower to the inclined figure of Antæus. (Dante, 'Inf.' canto xxxi. l. 135.) The Asinelli tower, also at Bologna, and close to the former, is 320 feet high, and 3 feet 6 inches out of the perpendicular. The leaning tower at Pisa is 150 feet high, and 13 feet out of the perpendicular. The campanile of Cremona is the highest in Italy, having an elevation of 395 feet.

The most remarkable, and in many respects the finest of the Italian campanili, is that of Florence, which is 269 feet high, and was constructed by Giotto in 1324. The plan is a perfect square, 45 feet on each side. The interior is divided into six floors, each of which is vaulted. The tower is ascended by 406 steps. The façade of the tower is Gothic in style, but mixed with somewhat of the Italian taste in architecture, which soon after prevailed over the Gothic. In the cut, the window-shafts appear plain, but in reality they are twisted; and the whole façade is covered with ornament. It is said that Giotto intended to surmount this tower with a spire 85 feet in height. The surface is veneered with coloured marble, which, though structurally objectionable, adds greatly to the richness of its appearance. Among transalpine towers bearing a marked resemblance to those of Italy, one of the most interesting is that of the cathedral at Seville, which is 350 feet high. It is said to have been begun by Abu Yusuf Yacub, in 1196, famous for other great architectural works, and is therefore contemporaneous with some of the most celebrated Italian towers. This tower is called La Giralda, or Girandillo, from a bronze female figure bearing that name; this figure, though it weighs a ton and a half, turns with the wind; it was cast in 1568, and replaced the four brazen balls which formed the original Moorish termination, but which were thrown down in 1395. (Gailhabaud; Street; I'Anson; Fergusson.)



[Campanile of the Cathedral at Florence, designed and built by Giotto.]

Wren, in his church towers, without actually copying Italian campanili, worked much in the spirit of their designers, and produced picturesque structures. Within the last few years, campanili of Italian form have been attached in this country to some churches and chapels built in the Romanesque and pointed Italian styles; and to some Italian renaissance town-halls, corn-exchanges, &c.; and they seem to form a favourite type with architects and civil engineers in constructing chimney-shafts. (See Rawlinson on 'Chimney-Shafts.')

CAMPHEN. [TURPENTINE.]

CAMPHILENE. [TURPENTINE.]

CAMPHINE. [TURPENTINE.]

CAMPHOCREOSOTE. *Carvacrol, Carnacrol* ($C_{20}H_{14}O_2$). A colourless, oily body obtained 1st, by acting upon oil of carraway with potash; 2nd, by treating the same oil with glacial phosphoric acid; 3rd, by treating the oil with iodine; and 4th, by acting upon laurel camphor with iodine. The following is probably the reaction in the latter case:—

$$\underbrace{C_{20}H_{16}O_2}_{\text{Camphor.}} + I_2 = \underbrace{C_{20}H_{14}O_2}_{\text{Camphocreosote.}} + 2HI.$$

Camphocreosote boils at 449° Fahr., is lighter than, and almost insoluble in water, possesses a disagreeable odour and a persistently bitter taste. It burns with a bright smoky flame.

CAMPHOETHYLIC ACID. [CAMPHOR.]

CAMPHOGEN ($C_{20}H_{14}$), *Cymene.* This substance is obtained when common camphor ($C_{20}H_{16}O_2$) is distilled with dry phosphoric acid. It is found also in the oil of cumin. It forms with sulphuric acid a compound called sulphocamphic or hyposulphocamphic acid, $C_{20}H_{15}S_2O_5 + HO$. [CAMPHOR.]

CAMPHOLENE. [CAMPHOR.]

CAMPHOLIC ACID. [CAMPHOR.]

CAMPHOLONE. [CAMPHOR.]

CAMPHOMETHYLIC ACID. [CAMPHOR.]

CAMPHOR is the stearopten, or one of the principles arising from the separation of the volatile oil of two trees; the one, *Cinnamomum camphora* (Nees v. Esenbeck), a native of Japan, China, and Cochin China, yields common or laurel camphor; the other, *Dipterocarpus camphora*, or *Dryobalanops camphora* (Colebrooke), a native of Borneo and Sumatra, called Sumatra or Borneo camphor. From these it is procured by different processes. It exists in every part, root, stem, branches, and leaves, of the first-mentioned tree, which is chopped into pieces sufficiently small to be thrown into iron vessels: these vessels are afterwards covered with earthen hoods, in which are placed rice-straw and rushes, heat being subsequently gradually applied The camphor is volatilised, and afterwards condenses on the straw, rushes, &c. This, after being purified from the intermixture of straws, is found in commerce under the name of crude camphor, distinguished into Japan or Dutch camphor, and China or Formosa camphor. But it still retains many impurities, and on arrival in Europe is refined, formerly exclusively at Venice, now also in England, Germany, and Holland.

From the *Dipterocarpus camphora* it is not procured by distillation, but exists in a solid form in the stem of the tree. In that part of the stem which should be occupied by the pith it is found, along with camphor-oil. When tapped or opened while young nothing but oil flows, but in time a great quantity of this oil assumes the solid form, and is found at intervals along the trunk in pieces a foot or a foot and a half long. The process of extracting the oil is effected by means of a Malay axe used to lay open the trunk at about eighteen inches from the ground, till near the heart, when a small incision is cautiously made, and the oil, if present, gushes out, and is received into bamboos and other vessels. If camphor is suspected to be present the tree is felled, cut into pieces about a fathom long, which are then split, and the camphor is found in pieces of the length stated, and about the circumference of the human arm. A tree of moderate size may yield about eleven pounds, while a very large one may produce twice that quantity. The camphor so obtained is called Se Tantong or head camphor; but the wood which surrounds the camphor on being scraped yields an inferior sort, called belly and foot camphor. The camphor from this tree is much less volatile and transparent than from the former. It is slower in its effects, but these are more permanent.

The oil is much prized and used in the East, but is not sent to Europe. So much more is the Borneo and Sumatra camphor esteemed than the other, that even in the markets of Japan seventy-eight pounds of the camphor of the latter country will be given in exchange for one pound of the former. The Bornean camphor is white, like chalk, but has the same smell and taste as that of Japan.

The process of refining consists in exposing the camphor in large ovens in flat glass baskets, along with a little charcoal, caustic lime, or chalk, during which the Sumatra camphor diffuses an odour like violets. Refined camphor is in round cakes, convex externally, concave internally, generally with a hole in the centre, each weighing about two pounds: the cakes are wrapped in strong blue paper, and exported in packages weighing about 500 pounds, containing 250 or 251 cakes.

Camphor is an organic substance of a peculiar kind, representing the volatile oils in a solid state. It differs from them, however, not only in being solid at the ordinary temperature of the air, but in not being converted by the oxygen of the air into a resin. It is so volatile that on exposure to the air it is entirely volatilised, and leaves no residuum. It has an unctuous feel, possesses considerable tenacity, and is not easily powdered, without the addition of alcohol, ether, or oil: the Sumatra camphor, however, can be powdered without such aid. It is nearly insoluble in water (requiring 1000 parts for its solution), but very soluble in alcohol, the ethers, eupion, creosote, the empyreumatic, volatile, and fixed oils. It is precipitated from most of its solutions, in an unchanged state, on the addition of water. Its specific gravity is 0·985; its ultimate composition is, according to Blanchet and Sell,

Carbon	79·28
Hydrogen	10·34
Oxygen	10·37

At 347° of Fahrenheit's thermometer it melts, at 400° it boils; it is easily ignited, burning with a bright flame and much smoke, but leaving no residuum. Its odour is strong and peculiar, its taste aromatic and bitterish, leaving behind it a feeling of coldness in the mouth.

Camphor acts upon the animal frame, both in the state of vapour and in the solid state. Few insects can endure the pungent odour of camphor; and in combination with strong acetic acid it acts as a powerful stimulant in cases of a disposition to fainting. When six or eight grains are received into a stomach in which there exists no increased sensibility, the person also not being in a state of excitement, the first effect is a feeling of burning and warmth, which gradually extends from the epigastrium over the whole body, occasionally accompanied with unpleasant feelings in the stomach, such as slight pain, eructations, &c. The pulse soon rises, becomes fuller and undulating; the heat of the skin is gently increased, and a warm and gentle but regular perspiration follows. All muscular actions take place with more ease; the nervous system in its whole range is roused and strengthened, and a feeling of general comfort pervades the whole frame. In from one to three hours this state abates, without leaving sleepiness, lassitude, or any unpleasantness behind.

A larger dose, half a drachm or two scruples, causes a burning heat in the palate and stomach, with pain, disposition to vomit, and great disturbance of the nervous system (the severity of which is determined by the amount of action on the stomach), giddiness, sense of constriction in the head, ringing of the ears, flickering of objects before the eyes, errors of vision, tremblings of the limbs, and impossibility of maintaining the erect posture, or of walking. During the continuation of this state, shiverings, with paleness of the skin and countenance, diminished warmth of skin, a slow, feeble, and contracted pulse, a laborious respiration, and threatenings of faintings or convulsions exist. When death results, the stomach is discovered to have been the seat of violent inflammation. Camphor may therefore be regarded as a powerful stimulant, at first local, but afterwards extending to the brain, spinal chord, and ganglionic system.

It is used in the low or sinking stage of almost all fevers, particularly where the nervous system is much depressed. At an earlier stage of the same disease, along with antimonials or opium, it often has a very beneficial effect on the skin, promoting regular and warm perspiration. It has also been used along with nitrate of potassa during the interval of an intermittent fever, to prevent a return of the paroxysm. In exanthematous fevers, such as small-pox, measles, scarlet fever, &c., it is often very serviceable during the eruptive stage, when the eruption does not come out freely, from want of sufficient nervous energy. In such circumstances, along with serpentaria, it is superior to any other means.

In chronic nervous diseases, such as cramps, tendency to convulsions of certain kinds, epilepsy, St. Vitus's dance, and similar disorders, it is often a valuable agent or vehicle for other remedies. Its external application as a rubefacient, in cases of cramps and neuralgic pains, is often of great service. The compound camphor liniment, which is a solution of camphor in volatile oil of lavender, alcohol, and ammonia, is an excellent solvent for iodide of potass, furnishing a valuable rubefacient. Combined with extract or tincture of hyoscyanum it procures sleep in cases of nervous restlessness.

In many cases of irritability of the urinary organs it is useful.

It is administered either in powder, in which case it must be minutely divided and mixed with other substances, or in aqueous solution (a very feeble preparation, though it possesses the odour), or alcoholic solution. When it is dissolved in oil, it forms a useful application to joints and other parts suffering from chronic rheumatic pains.

The use of camphor in the form of vapour from a bag carried round the neck, as a prophylactic during the prevalence of epidemic fevers, is hurtful. It produces depression of the nervous power, muscular debility, difficulty of respiration, and favours the very action of the morbific agent which it was intended to prevent. Its employment even in museums to protect the objects from insects, and among clothes to ward off moths, is injurious, if much be volatilised and diffused through the apartments; besides insects of the section *Tineæ*, which chiefly destroy wood, are not affected by it.

Camphor exists in several plants and trees besides those above mentioned; and a substance resembling camphor, and generally considered to be such, can be procured from many plants. It is in most cases, however, a hydrate of volatile oil, such as the Coumarin or odorous principle of the Tonka bean, Helenin from the Inula Helenium. An artificial camphor may be prepared by the mutual action of hydrochloric acid gas and oil of turpentine: it is white, possesses a camphor-like odour, is soluble in alcohol, &c.

Artificial camphor does not produce the lesion of the nervous system which is caused by ordinary camphor. It is therefore im-

portant to distinguish them. Artificial camphor, when heated, gives off the odour of turpentine, and, when ignited, burns with a *sooty* flame. The action of polarised light also serves to distinguish them. According to Mr. Bailey, if a fragment be placed on a microscopic slide, and a drop of alcohol added, it will first dissolve, and re-crystallise as the spirit evaporates. Examining this with the aid of a polarised light, the crystals of true camphor will seem as if beautifully coloured; but not so those of the artificial product.

CAMPHOR ($C_{20}H_{16}O_2$). Ordinary commercial, or laurel camphor, is a product of the *Laurus camphora*, a tree growing abundantly in China and Japan. The following is the method of extraction adopted in the latter country. The roots and wood of the tree are cut up and boiled with water in large pans fitted with heads in which are placed reeds or rice straw; on these the camphor condenses, being carried up by the steam. In China, the chopped wood is steeped in water, and boiled till camphor adheres to the stirrer, the liquid is then strained off, and on standing the camphor separates out. Obtained by either method it requires purification, and this is an operation extensively practised in England. It consists in mixing the camphor with lime, and heating on a sand-bath in thin glass vessels of the shape of an onion, about a foot in diameter, called bomboloes. As the temperature rises the camphor fuses, boils and condenses in the upper part of the vessel; at the end of the operation these are cracked by sprinkling with cold water, and the hemispherical cakes taken out and trimmed. They usually weigh from ten to twelve pounds.

Camphor obtained by sublimation, or from solution in alcohol, crystallises in octohedra or segments of the same; white, brilliant, and almost as transparent as glass. Specific gravity ·986 to ·996, according to temperature. It has a pungent bitter taste, and peculiar aromatic odour. It slowly evaporates at common temperatures, condensing in beautiful plates on the sides of the vessel in which it is contained. Light seems to favour this evaporation; it takes place most rapidly when camphor is in contact with water, and gives rise to those peculiar gyratory movements which are observed when small pieces are thrown on to the surface of that liquid. Camphor is tough, and difficult to powder, unless slightly moistened with alcohol, when the operation becomes an easy one. Heated, camphor fuses at 347°, boils at 399°, and distils without decomposition. Its vapour density is 5·317. It dissolves in one thousand times its weight of water, forming the camphor-water, mixture, or julep, of pharmacy. It is very soluble in alcohol, ether, acetic acid, fixed and volatile oils, chloroform, and bisulphide of carbon. Alkaline solutions seem to have but little action on it. It absorbs variable quantities of hydrochloric acid, sulphurous acid, and hyponitrous acid gases, oily bodies being formed, from which water separates the camphor unchanged. Heated with anhydrous phosphoric acid, fused chloride of zinc, or concentrated sulphuric acid, it yields *cymène* ($C_{20}H_{14}$) (*camphogen*) and water. Left in contact with excess of sulphuric acid for some days, it yields, on diluting the mixture with water, an oily body, colourless when pure, and having the same composition and state of condensation as solid camphor: it is changed into the latter by caustic potash. Chlorine acts slowly upon camphor, giving rise to unstable products, in which that element replaces hydrogen in variable quantities. Bromine forms with it a crystallisable substance ($C_{20}H_{16}O_2Br_2$). Iodine acts more energetically, giving rise to several compounds. Perchloride of phosphorus decomposes it, forming a body closely resembling artificial camphor; perchloride of antimony also strongly attacks it.

Camphrone, is the name given by M. Frémy to a liquid, obtained by passing the vapour of camphor over red-hot lime. Boiling point 167°.

Campholic acid ($C_{20}H_{18}O_4$), is formed by subjecting camphor and hydrate of potash to heat under pressure.

$$\underbrace{C_{20}H_{16}O_2}_{\text{Camphor.}} + \underbrace{KO, HO}_{\text{Potash.}} = \underbrace{C_{20}H_{17}KO_4}_{\text{Campholate of potash.}}.$$

It may be isolated by precipitating with an acid an aqueous solution of the resulting salt. It is insoluble in water. Heated, it fuses at 176°, and at about 482° boils and evaporates without decomposition. Its vapour density is 6·058. It is a monobasic acid. The lime salt ($C_{20}H_{17}CaO_4$) is formed by adding chloride of calcium to a hot solution of campholic acid in excess of ammonia: it is a crystalline powder.

Campholone ($C_{38}H_{34}O_2$) is a product of the dry distillation of campholate of lime.

$$\underbrace{2(C_{20}H_{17}CaO_4)}_{\text{Campholate of lime.}} = \underbrace{2(CaO\ CO_2)}_{\text{Carbonate of lime.}} + \underbrace{(C_{38}H_{34}O_2)}_{\text{Campholene.}}.$$

Campholene ($C_{18}H_{16}$) is a liquid hydrocarbon, obtained by distilling campholic acid with anhydrous phosphoric acid.

Camphoric acid ($C_{20}H_{14}O_6$,2HO) results from the action of boiling concentrated nitric acid upon camphor till no more red fumes are evolved. It crystallises out on cooling, and may be freed from any undecomposed camphor by dissolving in solution of carbonate of potash, precipitating with nitric acid, and re-crystallising from water. The crystals are either lamellar or acicular; they have a sour and somewhat bitter taste, Melting point 158°. This acid is but slightly soluble in cold water, more so when boiled; alcohol, ether, and the fixed and essential oils dissolve it with facility.

Camphoric acid unites with salifiable bases to form salts called *camphorates*. Not one of them is applied to any purpose whatever. Those which are soluble have almost all of them an aromatic bitter taste; the aqueous solutions are decomposed by the stronger acids, and they all burn and are decomposed by heat.

Anhydrous camphoric acid ($C_{20}H_{14}O_6$) is produced by distilling the hydrated acid, water being separated at the same time. The sublimate may be obtained in prisms of considerable length, by re-crystallisation from boiling alcohol. They are nearly tasteless, but after a time produce considerable irritation in the throat. Water dissolves them in small quantity. In ether they dissolve readily. Heated to 266° they begin to sublime in beautiful needles, at about 423° fuse into a colourless liquid, and boiling at 518°, distil over without undergoing decomposition. Anhydrous camphoric acid may be digested with hot water for two or three hours, without combination taking place; continued ebullition however ultimately determines the formation of the hydrate. The former does not precipitate neutral acetate of lead, the latter does so abundantly.

Camphoric acid is bibasic, and forms well defined salts with nearly all the bases. General formula ($C_{20}H_{14}M_2O_8$). They are for the most part crystallisable, soluble in water, and decomposed by the stronger acids.

Sulphocamphoric acid ($C_{18}H_{16}S_2O_{12}+4Aq$). When anhydrous camphoric acid is heated with fuming sulphuric acid, carbonic oxide escapes, and from the solution diluted with water, filtered through asbestos and exposed in vacuo, the sulpho-acid crystallises out. It may be purified by solution in, and recrystallisation from, alcohol.

$$\underbrace{C_{20}H_{14}O_{16}}_{\text{Anhyd.-camph. acid.}} + 2(HO, SO_3) = \underbrace{(C_{18}H_{16}S_2O_{12})}_{\text{Sulpho-camph. acid.}} + 2HO.$$

The crystals are colourless, bitter, soluble in water, alcohol, and ether. Exposed in a vacuum they lose four atoms of water. Between 320° and 330° they fuse and soon begin to decompose. They are dissolved by boiling nitric acid without decomposition. Sulpho-camphoric acid is bibasic, the neutral salts having the formula $C_{18}H_{14}M_2S_2O_{12}$.

Campho-methylic acid or *methyl-camphoric acid* ($C_{20}H_{15}(C_2H_3)O_8$), and *Campho-ethylic* or *ethyl-camphoric* or *camphovinic acid* ($C_{20}H_{15}(C_4H_5)O_8$), may be represented as camphoric acid in which an equivalent of hydrogen is replaced by the radicals methyl and ethyl respectively. They are obtained by digesting together for some time a boiling mixture of camphoric and sulphuric acids with the respective alcohols, namely, wood spirit and spirit of wine: on diluting with water they separate out. Both are colourless. Methyl-camphoric acid occurs in acicular crystals. Ethyl-camphoric acid is a thick oily body. They form salts with most of the bases.

Camphoric ether or *camphorate of ethyl* ($C_{20}H_{14}(C_4H_5)_2O_8$) results from the dry distillation of ethyl-camphoric acid according to the following equation:

$$\underbrace{2(C_{20}H_{15}(C_4H_5)O_8)}_{\text{Ethyl-camphor. acid.}} = 2HO + \underbrace{C_{20}H_{14}O_{16}}_{\text{Anhyd.-camphor acid.}} + \underbrace{C_{20}H_{14}(C_4H_5)_2O_8}_{\text{Camphorate of ethyl.}}.$$

Chlorine attacks this body, giving rise to camphorate of bichlorethyl ($C_{20}H_{14}(C_4H_3Cl_2)_2O_8$).

Camphoramic acid ($C_{20}H_{17}NO_6$) is obtained, combined with ammonia, on passing dry ammoniacal gas through an alcoholic solution of anhydrous camphoric acid; on adding dilute hydrochloric acid and evaporating, it crystallises out. When the crystallisation of this acid from a hot aqueous solution is seen through a microscope it presents a very beautiful appearance.

Camphoramide ($C_{20}H_{18}N_2O_4$) is prepared by passing a current of ammoniacal gas into a solution of anhydrous camphoric acid in absolute alcohol. On evaporation the camphoramide is left as a syrupy matter insoluble in water.

Camphorimide ($C_{20}H_{15}NO_4$). When camphoramic acid is heated to a few degrees above 300°, water is evolved, and camphorimide remains. It may be crystallised from solution in boiling alcohol.

Camphoranilic acid or *phenyl-camphoramic acid* ($C_{20}H_{16}(C_{12}H_5)NO_6$), as will be seen from the formula, differs from camphoramic acid in containing an equivalent of the radical phenyl ($C_{12}H_5$) in the place of an equivalent of hydrogen.

Camphoranile or *phenyl-camphorimide* ($C_{20}H_{14}(C_{12}H_5)NO_4$) bears a similar relation to camphorimide. Both the foregoing anilides are produced when a mixture of anhydrous camphoric acid and aniline is heated; they may be separated by digesting in solution of ammonia, when the phenyl-camphoramic acid dissolves and the phenyl-camphorimide remains insoluble.

A variety of camphor ($C_{20}H_{18}O_2$) called by Gerhardt *borneol*, and more generally known as Borneo or Sumatra camphor, is found in the crevices of the wood of the *Dryobalanops aromatica*, a noble tree growing in those islands. The old trees are cut down, split to pieces, and the little grains of camphor picked out by hand. The yield of one tree is generally very small, and but little of this variety is sent to Europe. It differs somewhat in its chemical and physical characters from ordinary or laurel camphor. As shown by the formula it contains two additional equivalents of hydrogen; its melting point and

boiling point are both higher, and when treated with anhydrous phosphoric acid it yields, as might be expected from its composition, *bornéène* ($C_{20}H_{16}$), instead of *cymène* ($C_{20}H_{14}$), obtained under the same circumstances from laurel camphor. The crystals also have a different form, are harder, and more brittle. In other respects it resembles the common camphor.

Camphor oil, or liquid camphor, is obtained from the young trees of *Dryobalanops aromatica*, by incising the bark. It is a mixture in variable proportions, of the hydrocarbon bornéène with borneol or solid Borneo camphor.

Camphor exists in small quantity in many plants, more especially in those of the natural order *Labiatæ;* for example, lavender, rosemary, sage, &c.

The various kinds, though they may be otherwise identical, act very unequally upon polarised light. Ordinary camphor causes the rays to rotate to the right hand: Borneo camphor does the same, but more powerfully, while that obtained from the *Matricaria parthenium*, a plant of the natural order *Compositæ*, and a species of chamomile (common feverfew), causes them to rotate to the left-hand. Camphor from the *Labiatæ* has no action whatever on the polarised rays. Camphoric acid also causes rotation in a direction similar to that induced by the camphor that yields it. For instance, the acid obtained from laurel camphor possesses dextro-rotation, while a solution of the camphoric acid of the matricaria camphor, exhibits levo-rotation. A mixture of the two has no rotatory power, thus bearing an interesting resemblance to the different isomeric modifications of tartaric acid.

Besides its position in the Materia Medica, camphor is used to some extent as a perfume.

CAMPHOR, ARTIFICIAL. [TURPENTINE.]

CAMPHOR OIL. [CAMPHOR.]

CAMPHORAMIC ACID. [CAMPHOR.]

CAMPHORAMIDE. [CAMPHOR.]

CAMPHORANILE. [CAMPHOR.]

CAMPHORANILIC ACID. [CAMPHOR.]

CAMPHORESINE. A black resinous matter of unknown composition, formed, along with other products, by the action of iodine upon camphor.

CAMPHORIC ACID. [CAMPHOR.]

CAMPHORIC ETHER. [CAMPHOR.]

CAMPHORIMIDE. [CAMPHOR.]

CAMPHOVINIC ACID. [CAMPHOR: *Campho-ethylic Acid.*]

CAMPHRONE. [CAMPHOR.]

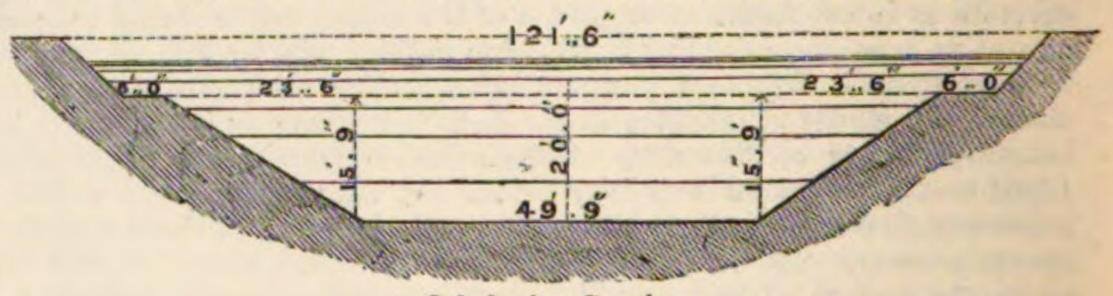
CANADA BALSAM. [BALSAM.]

CANAL. A word used by modern engineers to express, in an exclusive sense, the bodies of water and the works provided for the purpose of forming artificial navigable courses; the word *channel* being applied to the ordinary water-courses; *conduit*, to the artificial water-courses established for the distribution of that fluid for municipal consumption. Canals are also formed for the purposes of Irrigation [IRRIGATION]; but in speaking of them it is customary to prefix the specific title, and always to distinguish them as Irrigation Canals.

The execution of works for the purposes of improving the existing internal navigation of rivers, or for creating artificial courses for that purpose, dates from the very earliest antiquity; and it may also be observed to have taken place amongst nations whose civilisation has remained, in all other respects, in a very rudimentary state. Thus the Assyrians, Egyptians, and Hindoos, have from time immemorial boasted of the works executed by their governments, for both irrigation and navigation. The canals of China have long been famous, and indeed some of the details of Chinese construction, as their rolling bridges for instance, have served as models for Europeans; whilst the hydraulic works of the Mexicans and Peruvians justly excited the admiration of their Spanish conquerors; who, by the way, must have been acquainted with the first steps in the history of Italian hydraulic engineering, which took place precisely in the dominions of the house of Austria, near Milan. The formation of the canal de la Martesanna was, indeed, the first great advance made by European engineers in this branch of engineering, and it was there that Leonardo da Vinci for the first time, introduced the use of locks to regulate the level of the water in different reaches of the canal. About 1642, the canal de Briare, in the centre of France, was formed, under the patronage of Sully; in 1681 the first summit level canal between two oceans was opened by means of the Canal du Midi; in England, the navigation of the Itchin, between Winchester and Southampton, was opened about the same period, but it was not until nearly a century later that the execution of our lines of internal navigation assumed, under the guidance of such men as Brindley, Smeaton, Telford, Rennie, &c., the commercial and political importance they now possess. In the following notice, however, it is not proposed to follow the historical development of the system of canal navigation; but rather to trace broadly the principles which regulate the practice of the best engineers, illustrating them with references to the most celebrated works in various countries.

Canals for the purposes of artificial navigation are of three principal descriptions, according to the nature of the locality in which they are formed, and to the immediate objects they are designed to effect. There are canals established for the avowed object of allowing sea-going vessels to proceed to towns situated at some distance from the coast, which are known as *ship canals*. There are *lateral canals*, or those established on the banks of rivers, in order to obviate the natural obstacles to a barge navigation, whether occasioned by the irregularities in the volume of water flowing in the natural channel, or by the occurrence of rapids, falls, or other interferences with the flow of water, or with the regularity of the river's bed; sometimes also, lateral canals are formed in order to cut off the bends of the natural water courses. Lastly, there are the *junction, or summit level canals*, or those established for the purpose of connecting existing lines of navigation on the respective sides of a central elevated district dividing the water-sheds of a country. Many of the operations required for these various descriptions of canals are common to them all; but each of them presents distinctive features which render it necessary to consider them in detail.

Ship canals, being designed to accommodate vessels used for deep-sea navigation, must naturally be made of much larger dimensions than the canals exclusively devoted to purposes of inland navigation. Thus, the canal from the Severn to Gloucester has a width of 70 feet, and a depth of 18 feet, and it is able to receive vessels of 400 tons burden; the ship canal opened between Caen and the sea, has a clear width on the water-line of 100 feet, and is also intended to be used by sailing vessels of 400 tons burden; whilst the great North Holland canal, between Amsterdam and the Nieuw-diep, is not less than 124½ ft. wide on the water line, with a depth of 20 ft. 9 in., and is able to receive sailing vessels of about 1400 tons burden. The dimensions of the Caledonian canal are 115 ft. 6 in. on the water line,



Caledonian Canal.

and 20 ft. depth of water. Some of the lateral canals, however, have widths upon the water line as great as those above quoted; but in no case is their depth made to exceed, in any notable manner, about 8 feet; and the construction of the locks, and of the entrances to the tidal basins, is the most materially affected by this condition.

In forming a ship canal, great care is required in the selection of the position of the entrance from the sea, in order to secure free access at all times of the tide, and a permanent depth of water in the outer harbour. The entrance must, in fact, be placed in a sheltered roadstead, and in such a position as shall ensure its immunity from the action of any littoral current able to transport much alluvial matter; at the same time there must theoretically be a sufficient supply of clear water to allow of an efficient scour in the harbour. It is also essential that the direction of the entrance should be such as to obviate any possible inconvenience from the prevailing winds, so far as the entry of ships into the harbour, or their departure thencefrom, is concerned. By the application of a good system of dredging, and even by creating an artificial scour, it is possible to correct any natural tendency of a harbour to become silted up; but there are no simple artificial means by which the dangers resulting from a harbour's being exposed to the direct action of a head sea can be obviated; so that, after all, the exposition of the entrance to a ship canal, with reference to the position of the prevailing winds, is the most essential point to be considered in its selection. If, therefore, the outlet of such a canal to the sea should be situated upon an exposed coast, it will be necessary to form an outer harbour; and to establish the entrance locks to the artificial navigation under the shelter of the jetties or piers thus carried forward. When the entrance is, however, situated in a protected position, it must be designed upon the same principles with reference to the set of the currents, and to the facilities to be given to the passage from the canal to the open navigation, which will hereafter be described in the case of ordinary canal entrances.

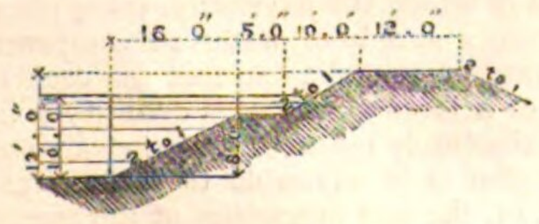
The lock gates of ship canals are necessarily of much larger dimensions than those of either of the other description of canals; for not only are the vessels they are required to pass larger than the ordinary river or canal craft, but they often require to resist greater differences of level on their upper or lower sides, in consequence of the rise and fall of the tides. On the Caledonian canal, the clear width of the lock chambers, at the level of the coping is 40 ft.; and a gate intended to pass a 1400 ton vessel must be at least 50 ft. wide at the narrowest part; and whereas, ordinary canal locks are made to overcome differences of level of 8 ft., it may often happen that the difference of level between the inner basin and the outer tidal surface of the entrance harbour of a ship canal, may attain as much as from 24 to 30 feet in height. In the North Holland canal the engineers have very wisely constructed the locks with two passages, one for large vessels, the other for small ones; thus obviating the necessity for wasting the time and water required to fill the large lock when a smaller one would suffice, and also, avoiding the unnecessary fatigue of the large gates. The mode of constructing lock gates, and the precautions to be taken to prevent their change of form, are described in the subsequent part of this article under the sub-head, *Locks*.

In ship canals it is desirable to form towing-paths on both sides, so as to be able to keep a ship steady during the prevalence of high winds; and it is customary to leave a narrow zone of shallow water on the banks of either of the towing-paths, for the purpose of destroying the effect of any waves in the canal upon the banks. The towing-paths themselves are finished at a minimum elevation of about 3 ft. 3 in. above the water line in the best canals of this description. The other works upon ship canals, so far as regards the provisions to be made to counteract interferences with the local drainage, or with the ordinary water courses of the district, are so precisely analogous to those required upon other lines of navigation, that they will be considered simultaneously with the latter.

Lateral canals are established, as was before stated, in almost all cases for the purpose of obviating the natural causes of disturbance in the river navigation resulting from the irregularities in the flow, or in the physical conditions of the bed of the stream; but they are also occasionally formed for the purposes of supplying irrigation channels, and for utilising the dynamical power of the water, when the rivers with which they are connected are of, comparatively speaking, insignificant volume, and are but little exposed to floods. The works executed upon the banks of the Lea, or of the Test and Itchin, in Hampshire, may be cited as partial illustrations of the combined use of rivers for navigation and industrial purposes; and perhaps it is allowable here to express the regret that the recent introduction of the railway system should have so entirely diverted public attention from the subject. For although the canals thus alluded to are far from being such as to ensure the greatest results from the water privileges concerned, the practical economical benefits to the public produced by them have, nevertheless, been of a very extraordinary description, even without any reference to the effect produced by the economical transport of bulky articles. It is, however, upon the long rivers of continents that lateral canals produce the most remarkable results; because in nearly all such cases, there is a large agglomerated population upon the banks of the river, and there is a rude species of navigation on the main stream, exposed to the inconveniences which unfortunately attend almost every large body of fresh water until it becomes distinctly under the influence of the tidal action. Such rivers are, indeed, exposed to great differences of level from the effects of floods, or of droughts; they are often divided into narrow and tortuous channels; at times they flow with great rapidity over shallows, and at others they present long reaches of stagnant water of great depth; and, in fact, they present, in their natural state, almost insuperable difficulties to the establishment of a regular system of navigation, even when the average velocity of the stream is not so great as to render such an operation physically impossible, in both the upward, and the downward direction. Lateral canals must, therefore, be considered to be essentially the means of correcting the natural defects of a river, or water course, for the purposes of navigation.

One of the most complete works of this description hitherto executed is, perhaps, the lateral canal of the Loire, which is made throughout its length to present a clear water way of 5 ft. 3 in. deep, by a width of about 33 ft. on the water-line of the canal, and of 17 ft. in the clear of the lock chambers, the latter being made about 101 ft. long, measuring from point to point of cills. The projected works for the improvement of the navigation of the Seine, are perhaps rather of the nature of a river improvement than of an ordinary lateral canal; but they may be cited as illustrating the dimensions it is considered in Europe advisable to adopt as the maximum in either of such cases. The locks are made as nearly as possible 400 ft. long by 40 ft. wide, with a fall of 6 ft. 7 in., and the normal width and depth of the channel are made about 75 ft. by 6 ft. 7 in.; for the barges used upon the Seine are often as much as 140 ft. long, by 23 ft. 6 in. wide, with a depth of 13 ft. 4 in. from deck to keel, and are able to carry as much as from 400 to 500 tons of merchandise. Upon many other rivers of the continent, of our own country, and of North America, similar works have been undertaken; and, indeed, the lateral canals of the Canadian rivers may be cited as being amongst the most remarkable operations of the kind yet attempted. The Long Sault canal, by means of which the dangerous rapids of the Ottawa are turned, has a width of about 140 ft. on the water-line, with a depth of 10 ft.; and its locks are not less than 200 ft. long by 55 ft. wide, with a depth of water over the cill of 9 ft. The Welland canal, which is in fact a lateral canal to the St. Lawrence between the lakes Erie and Ontario, has locks 130 ft. long by 22 ft. wide, and 8 ft. depth of water; so that the schooners which navigate the inland seas of North America are actually able to pass from them, through the lower St. Lawrence, to the Ocean.

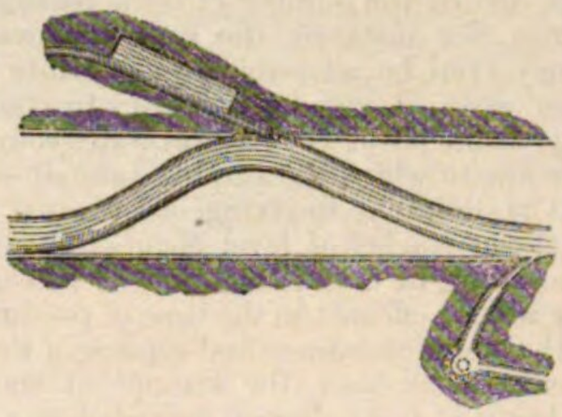
The details of lateral canals do not differ in any essential respect from



those of summit level canals, except inasmuch as the difference may be rendered necessary in consequence of their greater dimensions. It is, for instance, customary to form, both on ship canals, and large lateral

canals, what are called surf beams on either side of the main channel, for the purpose of destroying the effect of the waves caused either by the wind, or by the passage of vessels through the canal; but in ordinary canals this precaution is hardly necessary. Again, in lateral canals it is advisable to form towing paths on both sides, as in the case of ship canals; whilst a single towing-path will suffice for an ordinary artificial navigation. But the most peculiar works required for the formation of lateral canals are those connected with the passage from one bank of the river to the other, and those executed for the purpose of securing the uninterrupted discharge of the drainage of the cross valleys, or of the affluents to the main stream. In many cases these affluents are of sufficient importance to render it necessary to construct large aqueduct bridges; and at all times they require to be treated with care and attention in order to avoid floods.

In the annexed cut is represented one of the passages of the lateral canal of the Loire from one bank to the other of the river, rendered



necessary, be it observed, by the occurrence at a point lower down of a large affluent on the side thus abandoned; and as this work illustrates the various conditions attending similar operations in a very striking and comprehensive manner, it may be desirable to dwell a little upon its consideration. The Loire is a stream of a very irregular character, varying frequently and rapidly in volume; but it may be generally described as a mere thread of water in summer, and as a deep, broad, and rapid river in winter. Its tendency to inundate its banks has been resisted by the construction, at a very remote period of history, of banks insubmersible during ordinary floods, finishing at a height of at least 21 ft. 3 in. above the mean summer level of the stream—though some of the inundations of this valley have attained the height of at least 25 ft. These banks limit the course of the water during floods; but during the period when the river flows with its normal volume, the water is confined in a definite channel, by banks finishing at lower levels, as shown, so that moderate floods are allowed to discharge themselves freely, whilst the deep water channel is maintained. Under these circumstances the canal crosses the river by means of a small basin on the left bank, in which barges may lie in case the main stream should be in a state to render it unadvisable to attempt the passage; and from this basin there is a communication with the river by means of a sluice pointing in both cases down the stream, and whose axis forms an angle of 35 degrees with the bank. As the lock-chambers of this sluice are required frequently to keep out the river floods, they are provided with double sets of gates; one pointing up, and the other down, the stream of the canal itself; and the walls of the lock-chambers are finished off at the maximum height of the river banks. On the right bank, the canal recommences with a lock entrance of a precisely similar character to the one upon the left bank, terminating in a rather wide bay of the canal; which bay, in its turn, ends in a circular basin, wherein the barges are able to change their direction. It will be necessary hereafter to revert to the reasons for placing the entrances as shown.

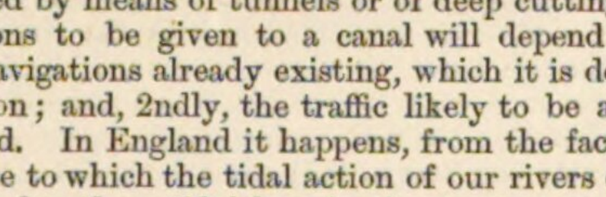
Summit level canals, or those intended to connect the existing lines of navigation upon the streams which flow from the respective sides of an elevated ridge of land, are forcedly made to overcome great differences of level, and thus give rise to the necessity for the execution of peculiar and special works for that purpose; and, as they are also forcedly carried through the districts wherein the rivers are of feeble volume, they frequently render necessary the execution of important works for the supply of water. The questions connected with the height to be overcome, and with the water supply, are indeed amongst the most vital ones to a summit level canal; and the success of such an operation depends almost entirely upon the manner in which they may have been solved. The general principles which must be borne in mind in the formation of such a canal are, in fact, that their total length should be the least possible under local circumstances; and that the difference of level be as small, and the number of locks as few, as is consistent with the economy of the first cost; for the evaporation from the water surface, the loss by filtration through the banks, and by the passage of boats through the locks, are dependent upon those conditions. These remarks apply equally when the fall is both ways, or when it is only in one direction, or when the canal has one or two branches; for there are instances in which summit level canals have all their fall towards one river, as in the cases of the majority of the Belgian canals, without descending on the other side from the highest reach of the navigation.

The precise direction of a line of artificial navigation may be, and often is, diverted from that which would theoretically have been

desirable, in order to allow it to accommodate certain local sources of traffic; but after due allowance has been made for these disturbing causes, the physical characteristics of the district must be carefully attended to. Trial levels on the line of the axis, and cross sections of the country, must be taken; the various springs and water-courses must be gauged, and the actual uses to which they are applied must be ascertained; and the geological characteristics of the district, both upon the surface and at some considerable depth, must be ascertained; as well for the purpose of ascertaining the capabilities of the district to supply the materials of construction, as for the purpose of obviating any tendency on the part of the natural ground to facilitate the passage of water. Very elaborate investigations must be made into the conditions of supply of water to the summit level, and that supply must be proportioned exactly to the wants of the navigation; the latter will depend upon the length of canal to be supplied by the summit or regulating bay, and will be influenced by the length, breadth, and height of the locks, and by the number of boats passing. Under some circumstances, when, for instance, the supply of water is liable to be deficient, it may even be advisable to substitute inclined planes for locks: in other cases, it may be necessary to compensate for the irregularities in the character of the natural water-courses, by forming impounding reservoirs, to which the surplus rainfall of the watershed may be stored. It is desirable, in laying out a canal of this description especially, that the reaches of level channel should be as long as possible in order to admit of a concentration of lockage; for by that means an economy will be effected in the time of passing boats through the locks, and in the superintendence and repairs of those works.

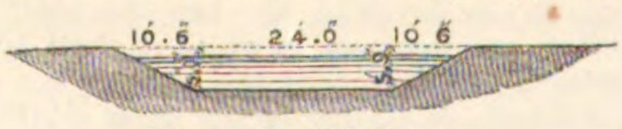
In some very exceptional cases, the summit of the depression, or pass, between the heads of two valleys is occupied by a small mountain lake, which pours its waters respectively into the natural channels of either side, and thus forms at once a regulating level, or reach, in the navigation. The pond of Longpendu is an illustration of this peculiar geological condition, for it pours its waters into the Loire on one side through the Bourbince, and into the Saône on the other, through the Heune, and thus acts as a natural feeder to the summit level of the Canal du Centre. The pond of Cony presents the same character, for it communicates on one side with the Moselle, and on the other side with the Saône; but this natural advantage has not yet been turned to any practical account, and the only artificial navigation of this part of France is effected by means of the Canal du Rhône au Rhin. In South America there is also a river of some magnitude which divides, in one part of its course, into two branches, one of which flows into the great river, the Amazonas, and the other into the Orinoco; but the occurrence of such natural facilities is very rare, and, in the majority of cases, the summits of the passes between the heads of two valleys have to be passed by means of tunnels or of deep cuttings.

The dimensions to be given to a canal will depend upon, 1st, the nature of the navigations already existing, which it is desired to place in communication; and, 2ndly, the traffic likely to be afforded by the locality traversed. In England it happens, from the fact of the extraordinary distance to which the tidal action of our rivers extends, that it is possible to confine the artificial navigation to very small barges; but upon the Continent, in North America, and in our own East Indian dominions, it would appear that there is a growing tendency to employ large boats, especially upon lateral canals or improved rivers. Thus, upon the Rhône the barges formerly used were about 75 tons burden, but the boats latterly constructed are made to carry about 120 tons; whilst upon the Seine and the Rhine (in the lower parts of their courses), barges are often used of a burden of from 400 to 500 tons; and in the United States many of the mixed canal and river barges are at least of 120 tons burden. In the execution of the artificial inland navigation hitherto formed, very great irregularities in the dimensions adopted have also prevailed in consequence of the opinions entertained as to the best description of barges; but the inquiries of the French engineers seem to have led them to the conclusion that it was desirable to group canals into two classes (so far as their dimensions were concerned), under the names of canals *à grande navigation* and canals *à petite navigation*. The former they made about 32 feet 9 inches wide on the floor-line of the canal, and 47 feet 5 inches upon the surface or water-line, with a depth of about 5 feet 9 inches;



Canal du Centre.

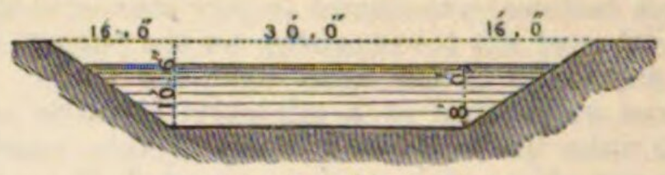
the locks being made 106 feet 8 inches long, by about 17 feet wide, and the towing-paths 13 feet wide. The canals *à petite navigation* are made only 35 feet wide on the water-line, with a depth of 5 feet, and the locks are constructed of 100 feet long by 9 feet 1 inch wide.



Average English Canal.

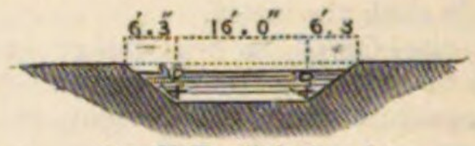
In England the dimensions adopted have varied within a very wide range, or from 31 to 48 feet upon the water-line, with an average depth

of 5 feet; but in some of our mineral districts the width is even reduced to 16 feet, and the largest of these secondary canals rarely



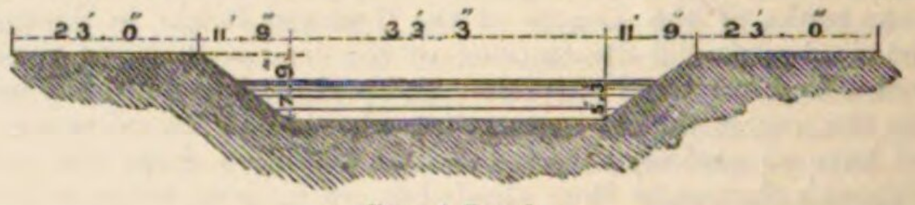
Chesapeake to Delaware.

attains the width of 28 feet. A similar irregularity in the dimensions of canals exists in America, for the St. Lawrence canal has a width of



Small English Canal.

150 feet, and the Morris canal is only 32 feet wide, on the water-line. It would be desirable that greater uniformity prevailed in this respect, for the inequality of dimensions often renders it impossible to pass the



Crozat Canal.

barges of one canal to another; and perhaps the dimensions adopted by the French engineers may, after all, be those which it would be the most advisable to adopt in the formation of new canals.

When the dimensions and direction of the canal are settled, the next point to be considered, as before said, is the mode of supplying the water required to compensate for the various sources of loss. These sources are of two descriptions, one of which is independent of the traffic, and the other in direct connection with it. The former of these sources of loss is produced by the evaporation from the exposed surface of the canal, the filtration through the banks, the leakage at the locks and lock-gates, and the loss which invariably occurs when a canal is refilled after being laid dry for repairs. The second source of loss is the one resulting from the consumption of water required to pass the boats through the locks, and occasionally from the sudden affluence of boats to the lower reaches of the canal.

The evaporation from any water surface will depend, of course, upon a very complicated series of phenomena, resulting from the conditions of the physical geography of the district in which it is placed. The laws affecting this branch of the inquiry would involve a discussion of some length, and they are, therefore, reserved for the articles, Evaporation and Hygrometry. For the present it may suffice to say, that in the temperate latitudes of Northern Europe, the average daily loss by the evaporation from the exposed surfaces of canals and their feeders is reckoned at from $\frac{1}{16}$ to $\frac{1}{12}$ of an inch; but in summer it often happens that the loss may reach even to four inches in the twenty-four hours; and, as it is precisely at this season that the ordinary compensations are deficient, it is essential to provide rather against the *maximum*, than against the *average*, evaporation. As to the loss by filtration, its amount must depend upon the care with which the works are executed, and the nature of the bed of the canal itself; but even when these various conditions are of the most favourable description, the loss of water may range between one-half and twice the amount lost by evaporation from the surface. It is usually considered that an allowance of two inches per twenty-four hours is sufficient to compensate for any loss of this description; but it must be observed, that the first time the water is turned into a canal, even with a most perfectly water-tight bed, a great quantity will be absorbed by the exposed surfaces before they become saturated, and this loss will be repeated on every occasion of laying the canal dry, though of course in a slighter degree than on the first occasion. It is usual to calculate upon the absorption of water at the rate of four inches in twenty-four hours, until the bed shall have become thoroughly saturated. In practice there is also another serious cause of loss of water upon canals, arising from defects in the execution of the locks and lock-gates; for, even when these constructions are new, they may allow a small quantity of water to pass, and after several years' wear they are certain to afford passage to increasing quantities. It is not rare to find the leakage of an old pair of gates equal to about 10,000 cubic feet per day.

The consumption of water for the passage of boats must depend upon their numbers, upon the relative proximity of the locks, and upon the direction in which the navigation takes place. Probably it is sufficient to provide a supply of water to compensate for this loss, calculated at the rate of 18,000 cubic feet for each boat which passes through the lock of a large canal: this quantity is no doubt in excess of that which is absolutely required, but the carelessness of workingmen is so great, that it is advisable to make a provision rather in excess, than short of, the real necessities of the case. It is customary, also, to allow about $\frac{1}{16}$ of the quantity absolutely required for the lockage, to compensate for the displacement of water which sometimes arises from the accumulation of boats in the lower reaches of a canal.

The dimensions to be given to the reservoirs, or to the regulating

bay when it serves the additional purpose of a reservoir, must be such as to ensure the fulfilment of all the above-mentioned requirements; but it is to be observed, that for many practical reasons connected with the regularity in the disharge of the water, and with the equalisation of the supply, it is preferable to make the reservoirs independent of the portion of the canal devoted to traffic. As, indeed, it may often be necessary to lay bare the whole bed of a canal, it must evidently be important to avoid the loss of water in the summit level, if that should happen to constitute a natural reservoir; and, at any rate, it must be more easy to control the passage of water from an artificial pond of this description, than it can be to divert the flow of the outlet of the natural drainage of a particular district. It would also be found, generally speaking, to be the case, that the water flowing into the summit level from the natural surface of the country would contain so much alluvial matter as to produce a tendency to silt up the channel, and that at times it might enter with sufficient violence to injure the banks. If, however, any springs, or rivers of a constant volume, should occur upon the line of the canal, they must of course be used as far as possible, and artificial reservoirs must only be considered as costly methods of supplying their absence, or of impounding the surface waters, which would otherwise be wasted. There are many very important practical questions connected with the execution of these works, which are at the present day of quite as much importance to the sanitary operations of some districts as they are even in canal operations; and it has therefore been considered advisable to treat them collectively under the head RESERVOIR.

Before entering upon the examination of the works of art upon a line of canal, it may be advisable to dwell upon some of the questions connected with the channel or bed. The first remark to be made is, that in the execution of a canal it is desirable to set out its course, as far as possible, upon that bank of the watercourse, whose direction it follows, which has the smallest number of affluents. Any natural streams which may exist must be either diverted into the canal, if their waters should happen to be of a proper quality, or they must be carried under its bed by means of culverts or of aqueducts. Again, it is advisable to make any change of direction in the line of the canal with as large a radius as possible; and even to provide, in such positions, an increase of width in the canal which should allow the boats to pass one another with greater ease, a precaution which, by the way, it is advisable to repeat whenever, from any accidental circumstance, there may be danger of the existence of any interference with the free movement of the boats, as, for instance, in long deep cuttings, or at the outlet of a tunnel, or at the end of a series of locks. In the execution of small canals such 'turn-outs' are of absolute necessity, and they must be placed so that the bargemen can easily see from one to the other. In large or in small canals alike, however, when intermediate stations or wharves are established for the convenience of local traffic, they must be formed beyond the line of the main waterway, so as to allow the navigation to be carried on uninterruptedly. If, therefore, there should be only one towing-path to the canal, the wharves should be placed on the opposite side to that path, and beyond the line of the main bed of the navigation.

Formerly the impermeability of the bed of a canal depended entirely upon the perfection with which the puddling had been performed; and though at the present day the use of hydraulic lime concrete in forming the bed has been largely applied by the French engineers instead of the ancient system, the use of puddle is still so common that it is necessary to allude to it. Puddle consists of clay, or loam, which is reduced to a tenacious but plastic state, by working and chopping it about with a spade, with the addition of a certain quantity of water, until the whole mass becomes homogeneous and so much condensed that it will not allow the passage of water through its texture. The best description of earth for forming puddle is a light loam, with a mixture of coarse sand or fine gravel; very strong clay is unfit for the purpose, on account of the great quantity of water it naturally holds, and of its tendency to shrink and crack in proportion to the evaporation of that water; and vegetable soil is even more unfit still, for the roots and leaves of plants it contains not only serve to render it porous by their decay, but they likewise offer temptation to moles, rats, and other burrowing animals. The ravages of these creatures are sometimes so serious in their effects upon the water-tightness of a canal bed, that it is considered to be necessary, when the puddle stuff does not contain gravel or sand, to mix those articles artificially in order to resist their attacks; care must, however, be taken that the size of the stones in the gravel should not exceed that of musket-balls. Telford used to consider that the operation of working the puddle consolidated it to such an extent as to reduce its volume to about two-thirds of its original bulk; and both in his specifications and in his publications upon the subject of canals he prescribes numerous precautions for its preparation and use. Of late years, however, the thick bed of puddle, which is always of difficult execution, and moreover always exposed to accidents, has been replaced by a layer of concrete; in the case of the Canal de St. Quentin, a lining of that material of only eight inches in thickness was found successful in resisting the passage of water through the banks, which it had not been possible to close by any of the ordinary methods. Whether puddle or concrete be used, it is, however, essential to protect the impermeable hearting of the bed by covering it with a layer of earth, which should be of sufficient thickness to prevent the gaffs used by the bargemen from entering or breaking its surface. This protecting coat is usually made about one foot thick, and when concrete is used for the lining it is advisable to form a step at the angles of the banks to prevent the protecting coat from slipping.

It is also to be observed, that in setting out a canal a longitudinal fall must be given in order to ensure the flow of the water with sufficient rapidity to compensate for the various sources of loss above enumerated, but at the same time that velocity must never exceed from twelve to fourteen inches per second. On some parts of the Erie Canal a fall of one inch per mile was given, whilst in others the rate of inclination was made only half an inch in that length, the consequence of which was, that when the navigation was active great attention was required to maintain the water at its proper level. M. Girard, the engineer of the Canal de l'Ourc, reasoning from the longitudinal profiles of rivers, thought that it was advisable to make the fall of that canal a portion of a large catenarian curve; and he therefore, in one part, made the inclination 0·0000625 m. per metre, and in the other 0·0001236 m. per metre. The effect of this change of inclination, however, was simply to produce a rapid current over those parts of the canal where the fall was great, and a very sluggish current in the more level portions; so that it would appear to be important, especially when the water in the canal is intended to have a definite rate of flow, to maintain a perfect uniformity in the inclination of its longitudinal section.

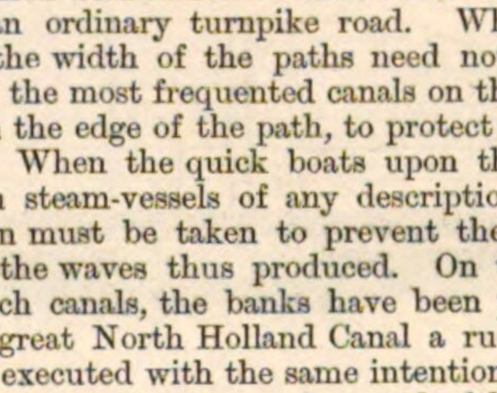
With respect to the width and depth to be given to the channel or bed, the ordinary dimensions of which have been previously described, it may be advisable to state that the principles which should regulate that width and depth are generally admitted to be that the bottom or floor line should be twice the width of the widest barge likely to enter the canal, with an allowance of from six to eight inches play on each side. The banks of the canal must, if formed in earthwork, have inclinations of one and a half to one; and indeed it would be preferable to make them two to one, unless the slopes are protected with masonry or with rough pitching; it is advisable also to form a small surf-beam even in small canals, in order to prevent the barges from injuring the banks. The depth of water should always be made at least from twelve to eighteen inches greater than the draught of the largest barges navigating the canal, in order to obviate any inconvenience from the accumulation of silt, or from the growth of aquatic plants, or from the occasional differences of level produced by the passage of the boats through the locks or basins. In some cases the growth of aquatic plants is encouraged as a protection to the banks; but unless they are kept within strictly defined limits they are susceptible of producing much injury to the navigation. The effect of the unexplained introduction of the *Anacharis alsinastrum* upon our canals has indeed been so serious as to merit more than a passing notice.

The towing-paths must be made at least from twelve to sixteen feet in width when that operation is effected by horses, and they should be made and maintained with almost as much care as would be observed in the case of an ordinary turnpike road. When the haulage is effected by men, the width of the paths need not exceed four feet; and upon some of the most frequented canals on the continent a small berme is raised on the edge of the path, to protect it from the friction of the tow-rope. When the quick boats upon the Scotch principle are used, or when steam-vessels of any description ply upon canals, especial precaution must be taken to prevent the banks from being washed away by the waves thus produced. On the Scotch, and on some of the French canals, the banks have been paved for this purpose; and on the great North Holland Canal a rude species of camp-sheeting has been executed with the same intention.

The philosophical considerations connected with the flow of water in canals, and with the resistance of water to the displacement of floating bodies, enter so intimately into the science of HYDRODYNAMICS, that they are reserved for that head.

In the construction of a canal, the most important works of art, using that expression to designate the works which require the employment of skilled labour, are, 1. the communications with the natural watercourses or rivers; 2. locks; 3. aqueducts, siphons, and culverts; 4. over-bridges; 5. tunnels; 6. basins, docks, or entrepôts, and intermediate stations. As was before observed, the construction of reservoirs will form the subject of a separate article.

1. *The communication with Rivers.*—In the cases of lateral and ship canals it is necessary to consider the conditions likely to affect both



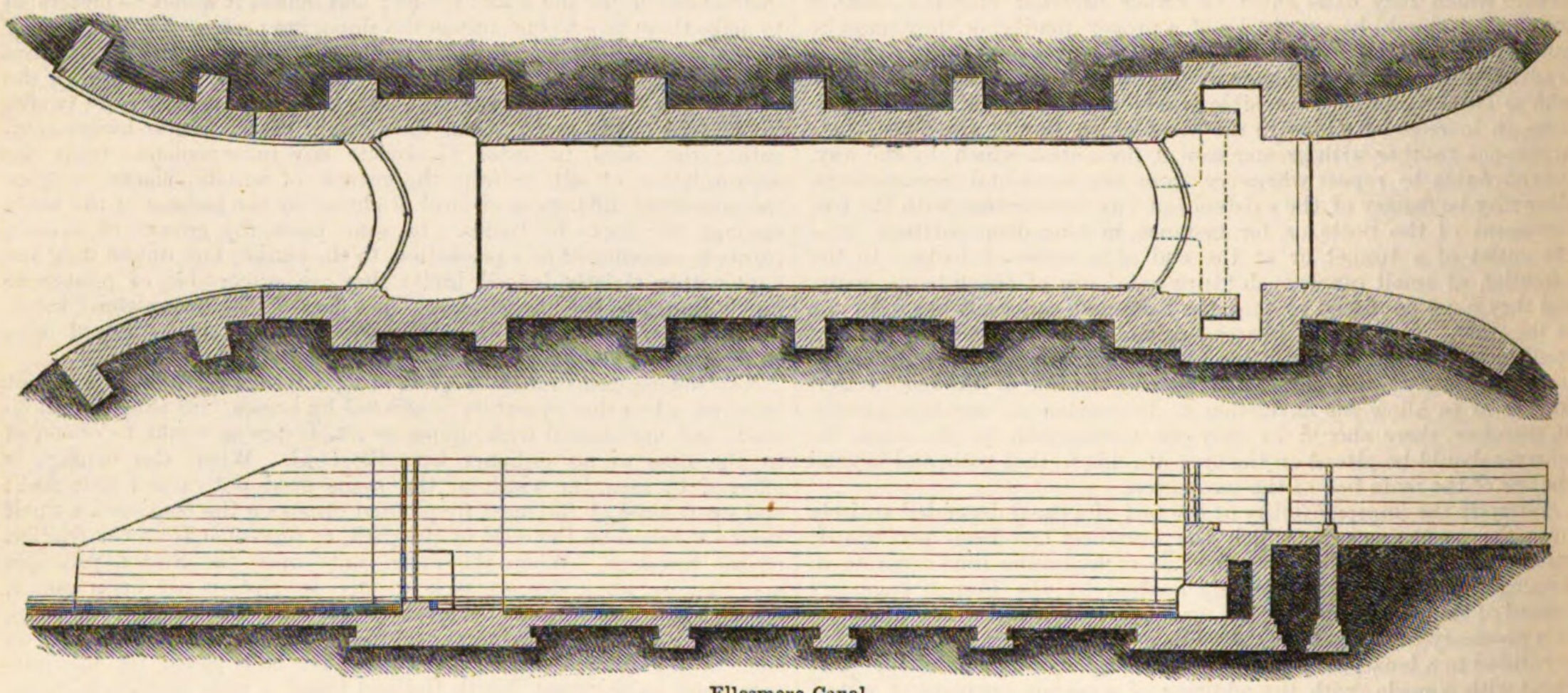
Entrance from river.

the upper and the lower junctions with the existing means of navigation; but in summit level canals the two ends are placed upon the

natural watercourses so as to render both of them in fact lower junctions. A careful examination of the best works hitherto executed shows that it is preferable to place the upper junction at rather an acute angle with the natural flow of the river, and to place the opening towards the down stream; for unless the boats are hauled back in this manner, they are exposed to be carried by the stream with dangerous violence against the entrance walls. If it were possible so to do, it would be desirable to form a basin near the guard-locks; but when this cannot be done, the junction should be formed by a long curve of considerable radius, and it should be made rather wider than the straight part of the canal. In order to prevent any inconvenience from the differences of level in the river, it is necessary to construct a lock with a pair of gates at each end; and it is also advisable to make a provision in the walls of the entrance channel for placing a dam, in case it should be required at any time to close the canal. The principal difficulty which occurs, however, in the construction of the upper junction of lateral canals, arises from the fact that they are usually established upon rivers of a very variable regimen, and that, under such circumstances, it is often necessary to form a cross dam to uphold the river waters. Very great precautions are required, in these cases, to prevent any injurious action from the water falling over the dam; and also to prevent the silting up of the pond of still water thus formed, or of the entrance and basin which are connected with it. In some cases the gates at the entrances are made in separate portions, to allow of their being easily used under considerable differences of level in the river; and in others, again, the first basin of a lateral canal is so arranged that its level may be alternately either above or below that of the river. Double sets of gates are required when this system is adopted, which must be made to point, as necessary, to the up or the down stream.

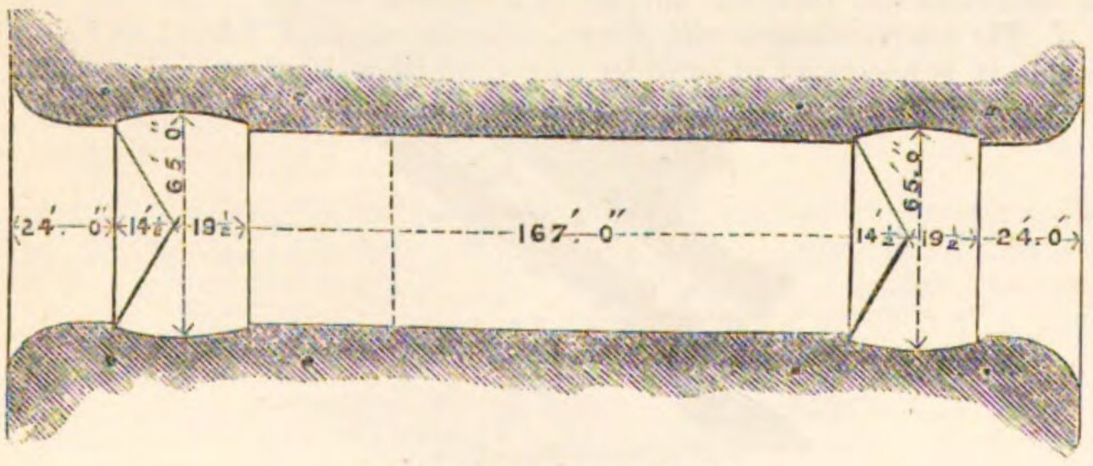
The outfall, or bottom junction with the river, may be either situated directly upon the stream itself or upon some branch communicating with it; and this latter course is adopted when there is danger of the outfall becoming silted up, or of the formation of natural bars, in consequence of the movement of the alluvial matters of the river. However this may be, the principles to be observed in forming such outfalls are—firstly, that the passage of boats from the canal to the river, or *vice versâ*, should be easy; secondly, that there should at all times exist a sufficient depth of water; thirdly, that it should be possible, if required at any time, to place sluices for the purpose of scouring the channel; and fourthly, that there should be a basin of considerable area, to receive the vessels about to pass from the one description of navigation to the other. The quays of the lock chambers, basins, and the platforms at the entrances must be kept above the level of the highest tides, or of the land floods; and it is advisable to keep the basin above mentioned open to the canal, so that all the lockage which may be required may be effected in the entrance channel. In establishing the lower cills of the locks of ship or lateral canals which terminate in tidal rivers, it is customary to make the level of those cills correspond with that of the mean low water of neap tides.

2. *Locks and Lock-chambers.*—Locks are, in fact, a species of pounds, in which a portion of the water of a canal is retained within a structure of such a nature as to allow its surface to correspond with the surfaces of either of the reaches of the canal, situated at different levels, which it may be desired to place in communication with one another. This is usually effected by constructing in masonry a small entrance channel, an upper pair of lock-gates, a lock-chamber, a lower pair of gates, and a small exit channel similar to the one on the higher level; and in the gates, or in the side walls of the chambers, small sluices or paddles are formed, through which the water may be passed from one level to the other, so as to fill the chamber to the upper level when the lower pair of gates is closed, or to lower it when the upper gates are brought into use. The operation of passing a boat from one level to the other is called 'locking up' or 'locking down,' as the case may be.



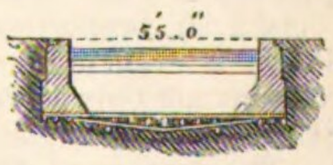
Ellesmere Canal.

The number of locks required to compensate any given difference of level must of course depend upon the fall given to them, and as a general rule, it may be asserted that all the falls of a canal should be made equal, in order to economise water in the passage of the boats. It is to be observed that great falls entail the necessity for more perfect execution of the work, because under such circumstances the hydrostatic pressure upon the lowest part of the floor is increased in proportion to the depth of the water; but evidently the greater the fall the fewer need be the locks to overcome a given difference of level, and therefore there will be an economy of time and of



Lock. St. Lawrence Canal.

superintendence when there are the smaller number of these machines. For the same economical reasons it is desirable to concentrate as many locks as possible within a short distance; but of course it is necessary in such cases to observe particular precaution in the mode of construction adopted, on account of the increased pressure upon the lower



lock floor, and of the danger of filtration. A number of consecutive locks, it is also to be observed, consume more water than the same number of locks separated by long reaches of canal would do. The falls given to locks vary, according to circumstances, between 5 feet and 10 feet, in canals with 6 feet of water; in ordinary canals, the fall is usually made from 8 feet to 8 feet 6 inches; and it is usually calculated that a boat would require as long a period to pass one such lock as it would do to traverse the distance of one-third of a mile on a level canal.

The parts of a lock may be considered to consist of—first, the upper chamber or head, with its gates, groove for dam, clapping cill, and breast wall; second, the lock-chamber, properly speaking, which extends from the upper breast-wall to the extreme point of the projection of the lower gates; and third, the breast-wall of the said lower gates and the lower chamber.

On many canals the form (on plan) given to the lock-chamber is made such as to give the side walls a concave direction to the water, with a view thereby to increase the resistance to the pressure of the

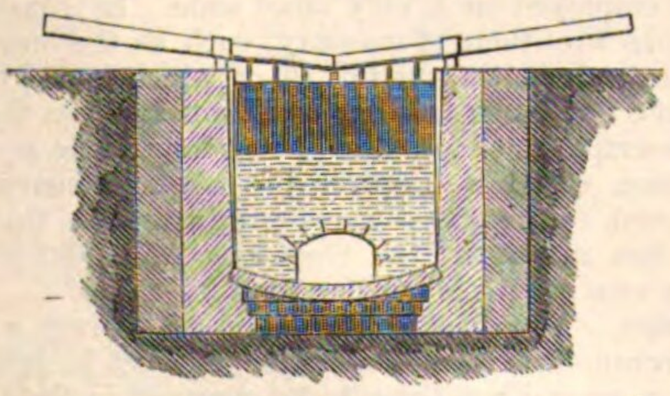
earth; and this pressure, it is necessary to observe, is greater than that of ordinary earth on account of the filtration which always takes place through the masonry of the locks, or from the upper reach of the canal. It is, however, more than questionable whether there be any real advantage in the adoption of this particular form; because the waste of water it entails is a permanent source of expense, and moreover it is tolerably certain that the extra thickness it will be necessary to give to the lock-floor will more than counterbalance the economy produced in the side walls. For these reasons, therefore, in the best modern canals the lock-chambers are made with parallel sides; and unless the chambers should be formed in the earthwork itself they are also made with vertical sides. The materials usually employed are masonry, whether of stone or of brick; but in Holland, the United States, our own colonies, &c., it may occasionally be advantageous to substitute timber, and even in some instances in our own country, cast-iron has been advantageously employed instead of masonry. Of whatever materials, however, the locks may be formed, the top of the side walls should be kept at least two feet above the maximum water-line of the upper basin.

It is usual to form grooves in the upper and lower chambers, to receive the ends of the temporary dams which may occasionally be required for the purpose of repairing the locks. These grooves should be made about 8 inches square, and of the whole height of the side walls; they must be placed at such a distance from the return walls as to allow a sufficient resistance to the various actions upon the foot of the dam. A reveal must also be formed on each side to receive the gates when open, and it should be made about 4 inches deeper than the gates, and 6 inches longer than their development. In order effectually to protect the gates when shut back in these reveals, the side walls must be carried from 6 feet to 7 feet beyond them on the upper side, before arriving at the groove last mentioned; on the lower side, the walls are prolonged beyond the reveals according to the width of the opening. Thus, for a 15 feet lock, they should be prolonged 12 feet; for an 18 feet lock, 14 feet; for a 20 feet lock, 16 feet; and so on.

In calculating the thickness to be given to the side walls of a lock it is advisable to consider that the earth at the back thereof is a semi-fluid denser than water, and to make the walls of a thickness adequate to resist its action. Some continental engineers make the thickness equal to 0·50 of the height; but in our own country this dimension ranges from 0·25 to 0·50, and the usual proportion adopted is 0·40, for the lock-chambers at least; because it is customary to strengthen the walls below the tail-gates, and when a lock is joined to a dam (as is very often the case in river navigation works), the end wall to the up stream is also strengthened, in order to enable it to resist the weight of water and the filtrations which take place. The floor of a lock is usually executed with an invert, to enable it to resist more effectually the hydrostatic pressure of these filtrations; and it is usual to calculate its dimensions on the supposition that it must be able to resist a head of water equal to the total depth of the lock. The thickness usually given to the floor of a 16 feet wide lock is, therefore, 2 feet 8 inches; and that of a 20 feet wide lock is 3 feet 4 inches. But whatever thickness be given, precautions should be taken to intercept filtrations from the higher level, either by driving a row of close piling or by stepping the foundations below the level of the ordinary parts of the chambers, so as to break the thread of any stream which might find its way under them.

The clapping cills are laid with a projection towards the upper level of the water equal to between one-ninth and one-third of the width of the opening; in the most modern canals the proportion is made between one-fifth and one-sixth, but Professor Barlow states that a projection whose sides would form an angle of about nineteen to twenty-four, or between one-eighth and one-ninth, is the most advantageous. It is customary to allow the cills to project about one foot above the floor of the lock, to form as it were a species of shoulder against which the lock-gates should be able to bear; and when the floor is executed in stone or brickwork, wooden or iron cills are introduced to receive the immediate shock of the gates. It is often desirable to execute the masonry at the back of the cills as a portion of an arch abutting against the side walls of the chambers.

When the upper chambers terminate with a breast-wall, that part of the structure is made concave (on plan) to the lock chamber, in order to economise masonry, and to receive the prows of the boats lying between the gates. Formerly these breast-walls were built vertical, and their upper surface was made to range exactly with those of the

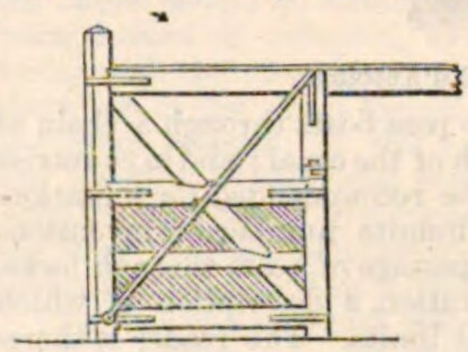


clapping-cills and the upper part of the chamber; but of late years the upper portion of the breast-wall has been made with an incline towards

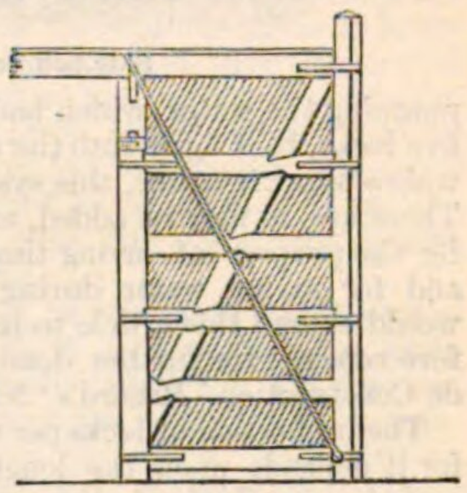
the chamber, and the face has been formed with a concave front towards the same direction, in order to break the fall of the water from the sluices in the gates; whilst in some of the most modern works, the breast-walls have been suppressed altogether. It is more than questionable whether there is any advantage in this latter system; and certainly it entails considerable trouble and difficulty in the original construction, and in the subsequent management of the lock-gates and chambers. Owing to the agitation produced by the escape of the water from the lower gates, it is advisable to prolong the floor of the lower chamber for some distance into the bed of the canal; and in many cases the entry to the upper chamber is also paved, in order to prevent the excavations which might otherwise be occasioned by the velocity given to the water at the upper gate.

Especial precautions must be observed in working the grooves intended to receive the heel-posts, as it is upon the correctness with which they fit that the water-tightness of the lock mainly depends. In some cases these grooves are executed in stone, in others of hard wood, and in others of cast-iron; but whatever be the material employed, the greatest attention must be paid to their execution. Care must also be taken that no parts of a lock project, and in fact that there shall be nothing in the respective chambers likely to catch the boats, or their loads, during their passage through the locks. Mooring-posts and rings must be provided occasionally, and every provision must be made to facilitate the passage.

In almost all the important canals the lock-gates consist of two leaves, fitting close, and bearing against the cills at the bottom, and against the grooves at the sides. Generally speaking they are made of wood, but of late years many gates have been executed in cast, or even in wrought-iron, or in a compound system of cast and wrought-iron and wood. These gates are composed of the upright posts, distinguished



Upper Gate.



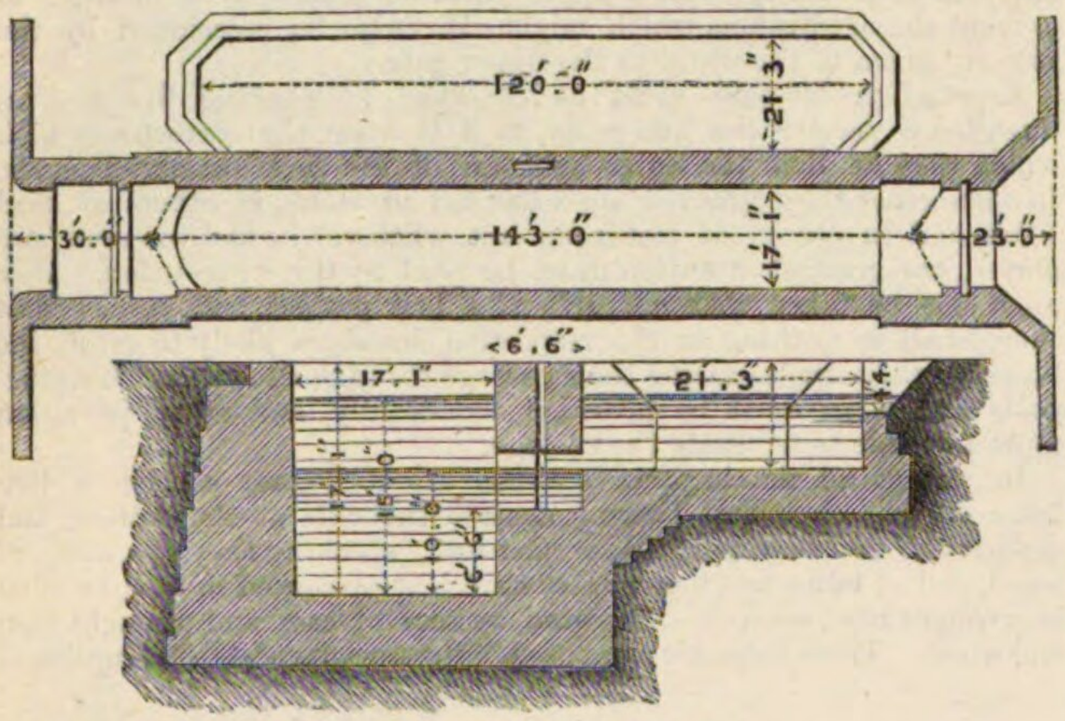
Lower Gate.

by the names of the *heel*-posts, and the *mitre* or *meeting*-posts; and of the *horizontal rails*, which support the weight of the water, and vary in number according to the height of the gate. Against these rails the planking, or the wrought-iron plates, as the case may be, are applied. The posts are kept about two inches clear of the floor of the chambers in which they work, so as not to bear immediately upon it in their revolutions; they are made from eight to ten inches above the highest water line, when they are opened by machinery, but are somewhat longer when that operation is performed by means of a long lever on the top of the gates, as is usually the case. The lowest rail, generally speaking, terminates at four inches from the floor, and the upper rail finishes about four inches above the water line; the intermediate rails are spaced according to the effort they are intended to resist. A raking brace, or strut, is introduced between the rails, and a wrought-iron tie connects the foot of the mitre-post to the top of the heel-post; these, together with the squares let in at the junction of the rails with the upright posts, serve to maintain the rigidity of the framing; but even with these precautions it is advisable, in preparing the gates, to keep the extremity of the framing at least two inches above the level it will occupy in execution, in order to allow for its shrinkage. In the most modern locks, the heel-posts turn upon a metal pivot let into the cill, and working in a reversed socket let into the post itself; and at the top they usually work in a metal collar, attached to the walls of the chamber.

The water is passed from one level in the lock to the other, by means of sluices formed on the gates themselves, or by means of small culverts in the side walls, or by siphons. The usual proportion of the water-way of the sluices to the width of the chamber is about 0·002 or 0·0013 to 1; the conditions which, however, regulate their dimensions are, that they should be made as large as possible, in order to allow the locks to be filled in the shortest space of time, without giving rise to a dangerous current or fall in the lower basin. The orifices should be placed, when vanes on the gates are used, as nearly as may be on the centre line of the leaves of the gates, in order that their jets may meet, and mutually destroy their effects. When side-culverts are used, the sluices are always placed on the upper side of the lock. It has, however, been found that there are so many practical objections to these side tunnels, that at the present day engineers have reverted to the old system of vanes on the gates. The dimensions of the vanes are ascertained by the formula $Q = m\,S\sqrt{2gH}$; in which Q = the quantity discharged; m = a coefficient expressing the relation between the real and the theoretical discharge, which is equal to 0·625 when

only one vane is used, and 0·548 when two vanes are used; S = the sectional area of the opening of the vanes; and H = the head above the opening.

When the navigation upon a canal is active, it may become advisable to place two locks side by side, so that one should be able to lock up, and the other down, simultaneously. In this manner it is easy to effect a considerable saving of water, by means of a culvert between the two chambers; and in some other cases, as in the Canal d'Antoing, the same object of economising water is effected by means of side chambers. On this Canal d'Antoing, a system was also adopted for



Side-pond on the Canal d'Antoing.

pumping the water, which had served to pass boats through a chain of five locks, back again into the upper reach of the canal; and in countries where water is scarce, this system may be recommended for imitation. There are, it may be added, an almost infinite number of inventions for the purpose of saving time in the passage of boats through locks, and for saving water during that operation, a description of which would extend this article to inconvenient limits. The reader is therefore referred for further details to Telford's Life, to Sganzin's 'Cours de Construction,' Minard's 'Navigation des Canaux et des Rivières.'

The proportion of locks per mile of canal is necessarily very variable; for it depends upon the longitudinal section of the country to be traversed. In England, the average upon the more important canals ranges from 1 lock in 0·33 mile to 1 in 1·43; in France, the average varies from 1 in 0·66 to 1 in 1·89; and in America, there is upon the Erie Canal on the average 1 lock in every 4·36 miles. Occasionally, in very hilly countries, locks are dispensed with altogether, and the boats are raised by means of machinery upon inclined planes, from one level to the other. Thus, in the Duke of Bridgewater's subterranean canals, there is one inclined plane 151 yards long, by means of which a difference of level of 35½ yards is at once overcome. On the Shropshire Canal there are three inclined planes, respectively of 126, 120, and 207 feet rise, executed about the year 1792; and Telford executed an inclined plane of the same description on the Shrewsbury Canal, of 223 yards in length and 25 yards rise. On the Canal du Centre similar inclined planes are used, on account of the want of water; and on the Morris Canal, Pennsylvania, there are no less than fourteen such planes, each of which has a rise of about 100 or 102 feet. In the latter case, the barges are run into a species of lock, which is carried upon rollers, so that the barges are kept constantly afloat. It is said that the economical results of these inclined planes are very satisfactory; but evidently they can only be applicable upon canals of small section, for even in the case of the Morris Canal, the weight of the boat, lock, and carriage is about 85 tons, and in a canal of larger dimensions the weight would increase in so marked a proportion as to increase the cost of lifting the load to a very serious extent. The vertical lift used upon the Bridgewater Canal seems to be the best for large canals.

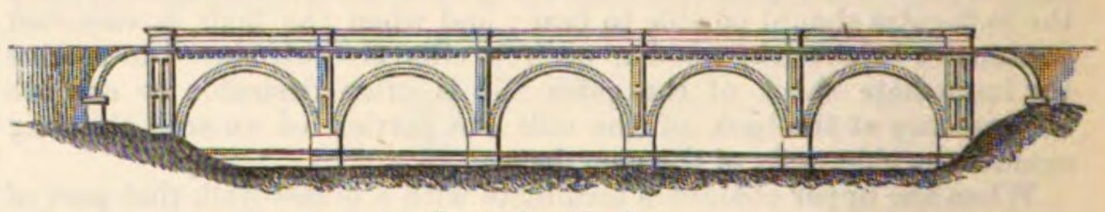
3. *Aqueducts, Siphons, and Culverts.*—In traversing a great length of country, especially in a hilly or mountainous region, it may often happen that the canal would meet in its course streams holding much foreign matters in suspension, or subject to floods or droughts, of a capricious and dangerous character; and these streams may occur at different levels with respect to the water-line of the canal, requiring consequently a different treatment in each case. If the natural level of the stream should be above that of the canal, of course, it must be carried over it at once by an aqueduct; but this is a case which rarely occurs, and it is far more common to find that it is necessary to pass the water under the canal by means of a culvert, or of a siphon aqueduct. The construction of the culverts is simple enough, for all that is required of them is, that their water-way should be sufficiently large to carry off any flood which may occur in the upper parts of the valley they serve to discharge, and that they should be executed of impermeable materials, both for the purposes of resisting leakage from the canal above them and from their own bed. Greater difficulties, however, attend the execution of the siphons, for they are at all times difficult to repair; there is moreover great danger of their leaking, in

consequence of the hydrostatical pressure acting upon their lower surfaces; and there is a tendency to choke up the passage, from the accumulation of silt or alluvial matter. So great, indeed, is the danger from the latter cause, that siphons should only be used for the most limpid waters, and under any circumstances settling reservoirs should be formed at their entrances.

If the lateral stream thus encountered should attain considerable dimensions, it will become necessary to carry the canal over it by means of a bridge aqueduct, whose form, mode of construction, and dimensions must depend upon the particular circumstances of the case. It is very rarely that the width of the channel is made more than 8 inches on each side beyond the extreme width of the barges using the canal. Only one towing-path is absolutely necessary, though it is usual to execute two, and these paths are made 3 feet wide when the haulage is effected by men, or 6 feet wide when it is effected by horses. When, as it is usually the case, the aqueduct is executed in masonry, the actual bed of the canal ought not to be commenced until the centres have been struck, and the settlements of the materials have taken their full effect upon the piers and arches of the substructure. In the best modern works of this description, the bed itself is formed of hydraulic concrete; and under those circumstances, a strong timber guard is required to protect the concrete from the jars or shocks of the barges; as also an earthwork lining if the bargemen are likely to use their gaffs. The primary object to be borne in mind in executing an aqueduct being, in fact, that it must be water-tight, it is impossible to attach too much importance to the mechanical execution of the bed, and in some cases the engineers have even gone so far as to line the trough with lead. This was a needlessly expensive method of securing the desired end; but it is impossible to exaggerate the necessity for observing the minutest precautions to insure the impermeability of the channel, or the immediate removal of any water which may force its way through, without its being allowed in any way to compromise the solidity of the structure. For this purpose it is advisable to form small aqueducts in the haunches of the arches; and the warm air-flues, which are occasionally formed in these structures, may likewise be made to contribute to the same end. The water should be introduced as soon after the execution of the bed as possible, in order to prevent any fissures from the sudden drying of the lining.

Great difficulties are at times encountered in executing the foundations of canal aqueducts, from the fact of their being necessarily constructed in the beds of rivers, which are composed of loose alluvial matters of a great depth. This was the case with the aqueducts of Digoin and the Allier, erected over some of the torrential affluents of the Loire; and still more markedly with the great Solani and Godavery aqueducts recently executed in India. In the former cases, the foundations were protected by establishing a floor, over the whole of the water-way, between an upper and lower face-wall, and a close row of sheet piling was driven in front of each of the latter. In the cases of the Indian aqueducts, the native system of founding upon wells was adopted; for brick wells were sunk to a considerable depth, and subsequently filled in with concrete, forming, as it were, masonry piles, on which the superstructure was erected. Local considerations must determine the choice of the system to be adopted in any particular case, the object to be effected being to effectually guard against any tendency in the waters of the stream traversed to undermine the foundations.

Amongst the most remarkable canal aqueducts hitherto executed, it may be worth while to mention those upon the line of the Ellesmere and Chester Canal, by Telford, on account of the novel application in them of cast iron to building purposes. In the Chirk Aqueduct, the bed only of the canal was formed of that material; but in the Pont y Cysslte Aqueduct, the whole of the upper structure was executed in cast iron. The Lune Aqueduct, by Mr. Rennie, is a very bold and



Lune Aqueduct.

elegant structure; and there are some very remarkable works of this description near Leeds, executed by Mr. Leather, in which cast iron has again been employed on a very large scale. In France there are some remarkable aqueducts of masonry, such as the ones before mentioned at Digoin and Guétin, the former of which is 810 feet long, and the latter is 1298 feet long; and in the United States there is a great work of this description, of wood, 1077 feet long. The aqueduct of the Ganges Irrigation Canal is however the largest construction of this nature yet erected, for its actual water-way is not less than 170 feet in width by 10 feet in depth; the Godavery Aqueduct is of a smaller section, but its total length is not less than 2248 feet.

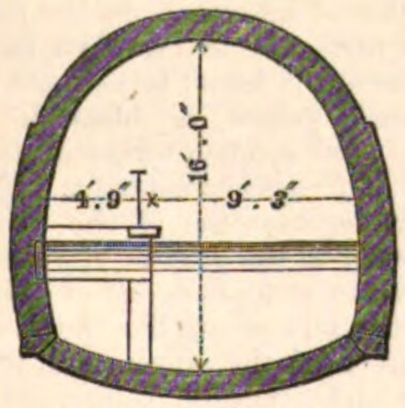
4. *Over-Bridges.*—The bridges to be erected over a canal being designed to accommodate the local traffic, it must be evident that the most important general condition to be observed in their construction is, that they should be kept as low as possible, consistently with the service of the navigation. It has been found, practically, that upon

canals having locks of 17 feet clear width, a height of 13 feet from the water-line to the under side of the keystone is sufficient; but that if the barges frequenting the canal are so large as to require the locks to be 26 feet in width, the clear height as above must be made 18 feet. Under these bridges, however, the water-way is usually made about from 1 foot 4 inches to 2 feet wider than it is made in the locks, because the boats do not stop to pass under them as they do to pass through the locks; for this reason also it is desirable, wherever it is possible so to do, to carry the towing-paths under the bridges, in order to avoid the necessity for casting off the tow-ropes. Over-bridges should always be placed in positions where the canal has a straight run above and below them of from 200 to 300 yards.

In very flat districts, as in the fen-lands of the east of England, in Holland, or in Belgium, it is often necessary to execute lifting, or swing bridges, in order to avoid the necessity for raising the level of the approaches. There are many ingenious modifications of this class of structures, such as the lifting bridges upon the Surrey canal, wherein the roadway is raised bodily by means of counterpoises; the ordinary Dutch lifting bridges worked by long levers fixed above the ground; the ordinary turning bridges, like those introduced upon the Regent's canal; or the rolling bridges recently applied upon some of the railway lines. But upon whatever principle these moveable bridges may be constructed, they are always costly in their first execution; and their subsequent maintenance, working, and repair always entails a considerable outlay. If possible, therefore, the erection of this description of works should be avoided, and permanent bridges with proper approaches substituted for them, especially in the neighbourhood of towns.

5. *Tunnels.*—When the cutting required for the purpose of carrying a canal at a given level becomes too expensive, from the mass of earth to be removed, and it is not considered advisable to diminish the depth of excavation by the introduction of locks; or when it is considered that there is a probability of meeting a copious supply of water by passing through the heart of a hill; tunnelling should be resorted to. Local considerations must at all times seriously affect the economical bearings of these questions, but, as a general rule, it is thought that when the excavation for a canal would exceed 50 ft. in depth, there would be an advantage in executing a tunnel rather than in executing such a cutting. Some engineers, in order to avoid the construction of tunnels, which certainly entail many inconveniences upon the navigation of a canal, reduce the width of the water-way in deep cuttings to that which is absolutely necessary for the passage of one boat; and, indeed, it is to be observed that the majority of canal tunnels also are made of this width. But the economy thus attained in a cutting is far less than might have been expected, because the cubical quantity of earth-work in it is mainly affected by the angle of the slopes, and the saving produced is, in fact, only equal to the amount resulting from the multiplication of the diminution of the width by the depth. There is also an objection to diminishing the width of a canal in such positions, arising from the obstruction thus offered to the passage of the boats from the smaller area of the water surface; and for the same reason it is not desirable to reduce the section of the channel even in tunnels.

Whether the tunnel be executed to allow the passage of one or two boats simultaneously, it is customary to give a play of about 2 ft. on either side beyond the width theoretically required. On the Canal de St. Quentin the tunnels are executed with towing paths on either side of 4 ft. in width: in the Paddington and the Harecastle tunnels, there



Harecastle Tunnel.

are towing-paths only on one side, and of smaller dimensions than is desirable; whilst in the Blisworth tunnel there is no towing-path, and the boats are propelled by a process technically called "legging," in which the bargemen lie on the top of the barge, and push it forward by pressing their feet against the top of the arch. In some cases the boats are hauled through the tunnels by means of tow-ropes fixed at the respective ends; and again there is, in other canals, special machinery for the purpose of haulage.

The height to be given to the underside of the lining of a tunnel above the water-line is usually made between 11 ft. and 16 ft.: in the case of the canal between the Chesapeake and Ohio, this height was made 17 ft. 3 in., and in that of the canal St. Quentin it was made 20 ft. In all these cases it is supposed that the masts of the barges are either struck or lowered; but in the project for the great inter-oceanic canal, by M. Garella, for uniting the Atlantic and Pacific, it was suggested that the clear height of the tunnel, near the summit level, should not be less than 122 ft. At all times, however, the clear

height to be given must depend greatly upon the transverse section of the tunnel, and this will in its turn be affected by the nature of the strata traversed. For instance, in the Thames and Medway tunnel the chalk was so fissured, and the strata were inclined at such an angle, that it became desirable to throw out the tunnel to the form of a Gothic arch, rising occasionally as much as 31 ft. 8 in. above the water-line: whilst in the more uniform strata met with in the Harecastle tunnel, the height could at all times be kept within the limits originally intended. Whatever the form of the sides and of the vault may be, the bottom should be formed by an invert. The thickness of the lining (and it may here be observed that it is very rarely indeed that the lining of a tunnel can be dispensed with) must depend upon the nature of the ground traversed, its hydroscopic powers, and the inclination of the strata. It appears, from an examination of the most successful examples of such works, that the extreme thickness to be given to the vaults need not exceed 3 ft. 4 in. or 3 ft. 6 in. even in the largest tunnels, and the worst descriptions of soil; the sides should be made about from 6 in. to 12 in. thicker. [TUNNELS.]

6. *Basins, Docks, and intermediate Stations.*—At the termini of an important line of navigation it is necessary to provide accommodation for the transaction of the business to which it gives rise, or to provide wharves where the barges may unload or receive their cargo, and where the goods they transport may be stored for sale, or transshipped at once into seagoing vessels if required. It must, therefore, be evident that the nature of the terminal arrangements must depend greatly upon the local conditions under which they are placed; and that the principles which would be applicable to a ship canal would be very different from those applicable to a mere summit level one. The only invariable rules which apply to this class of works are, that the area of the basins should be sufficient to allow the barges or vessels, which are being loaded or unloaded, to lie alongside the wharves without interfering with the movement upon the canal itself; and that the level of the water in the basins should be maintained independently of that in the inner reaches: in the best canals there are therefore locks at the junction of the canal with the basins, for the express purpose of isolating the level of the former if it should be requisite so to do. In the cases of canals terminating in a tidal river, the observance of this precaution is more than usually imperative.

The area of a terminal basin depending, as was above stated, on the character of the vessels resorting to it, it follows that the basin intended to serve the purposes of both the canal and the deep sea vessels must be much larger than the terminal basin which is exclusively devoted to the purposes of the inland navigation. For ordinary working operations, it would appear that it is not desirable to allow more than two tiers of vessels to lie alongside of the wharves of a dock at the same time; and it is also known that it is essential to leave a space between the vessels moored alongside the quays, which should allow at least one of the longest of the vessels using the dock to move freely in any direction. The minimum width of a basin must, then, be equal to at least four times the width, plus once the length, of the largest vessel it is intended to receive, and plus the space to be left between each of the elements of the calculation; and its length should on the average be equal to at least ten times that of the longest vessel using the basin, plus four times the width of the said vessels, in order to allow some boats to moor at the ends. The unloading machinery, cranes, staiths, derricks, and timber slips, must be regulated by the precise nature of the traffic of the canal, and they cannot give rise to any very general observations. The terminal basin of the Regent's Canal is one of the most perfect structures of this description in existence; the Basin de la Villette, in Paris, is a very fair specimen of an inland basin in a great town; whilst the details of the Entrepôt des Marais may be advantageously studied, on account of the ingenious combinations therein effected to facilitate the vexatious operations of the French Custom House.

Intermediate stations upon a canal must be established mainly upon the same conditions as have been above traced for terminal stations; observing, simply, that precautions must be taken to prevent the barges lying alongside the wharves from interfering in any manner with the through traffic. It would, indeed, be advisable to place any important intermediate stations upon lateral branches from the main line of the canal.

Statistics.—It would be difficult at the present day, when so many canals are being transformed into railways, to give any very accurate statistics of the lengths of canal actually in existence. From the observations of Mr. G. Rennie, it would however appear, that in the years 1838 and 1839, before this description of change had taken place to any notable extent, there had been formed in Great Britain about 2236 miles of improved river navigation, at a cost of 6,269,000*l.*; and a total length of 2477 miles of artificial canal navigation, at a cost of 28,406,389*l.* In the United States there had been executed up to the same period about 2000 miles of canal, at a cost of about 9,200,000*l.*; and in France there were about 1974 miles of canal, which had cost about 12,257,184*l.* The average annual cost of maintainance varies from 180*l.* to 60*l.* per mile of canal, according to the nature and activity of the traffic. As a general rule, it may be assumed that the cost of a canal may in England be estimated to be about 4*l.* per yard lineal, with an addition of 1000*l.* per yard vertical of lockage, or rather with an addition of about 3000*l.* for every lock of ordinary dimensions. The

cost of basins and intermediate stations is not included in these prices, on account of their very variable importance; but as a rude approximation, they may be assumed to cost about one-tenth of the total cost of the rest of the canal. Common, under, or over-bridges are not included in the above prices; but they may be considered to cost about 500*l.* each.

CANA'RIES, in music, a quick dance-tune, in three-eight time, said to have been imported from the Canary Islands, though in all probability it was exported thither from Normandy by John de Bethencourt, who invaded them at the close of the 14th century. Purcell has, in his 'Diocletian,' introduced the *Canaries*. His tune is in two strains of eight bars each, in three-eight time.

CANARY GRASS (*Phalaris Canariensis*) is an annual grass, cultivated for its seeds, with which cage birds are fed. The consumption of this seed is so considerable as to make it an article of commerce. Canary seed is chiefly cultivated in the Isle of Thanet in Kent, and about Sandwich. It requires a good soil, neither too light nor too wet, and an open country, without many hedge-rows; for small birds are so fond of the seed, that where they abound it is scarcely possible to protect the crop from their depredations. The plant grows like a strong grass, with an oval spike at the extremity of the stem. The seeds are closely enveloped by a strong chaff or husk, from which they are not easily separated; they are oval and pointed at both ends, and of a bright straw colour. The kernel of the seed is pleasant to the taste, and has the flavour of nuts.

Canary grass has been tried in a green state for cattle; but besides the price of the seed, which is high compared with that of other grasses, it has not been found sufficiently abundant or nutritious to make it preferable to any of the grasses usually cultivated for that purpose. When sown for the seed it is best sown in drills, about half a bushel to the acre, at the distance of eight or nine inches from each other; this admits of hoeing, by which the quantity of seed produced is much increased, and it is kept free from the admixture of weeds. When it is reaped it is left for some time in heaps or wads, and exposed to the dews: this does not injure the seed, and by softening the husk facilitates its separation by threshing. The same effect may be produced by breaking off the heads from the stem with the flail, and pressing them close in casks or bags before they are perfectly dry; a slight fermentation takes place which renders the chaff brittle, and after some time the seed comes out very readily. The same thing is done with clover seed. The produce of an acre of canary seed is from three to five quarters.

CANCER, a disease of a malignant character. This disease depends upon the exudation from the blood of a peculiar matter, accompanied by the development of fibres and cells. This exudation produces a tumour or swelling, which ultimately ulcerates, forming an open sore. Dr. Bennett divides these tumours into three kinds: 1. The structure is very hard, and principally formed of fibres (*schirrus*). 2. The structure is soft, containing a copious milky fluid, in which numerous corpuscles swim (*encephaloma*). 3. The structure has a fibrous basis, so arranged as to form areolæ or loculi, containing a gelatinous gum or glue-like matter (*colloid cancer*).

1. *Schirrus.*—On making a thin section of a schirrus tumour, it is found to be principally composed of filaments, which vary in size and run in different directions, sometimes forming waved bands, at others an inextricable plexus, among which nucleated cells may be seen to be mixed. These nucleated cells are peculiar to cancerous growths, and are called *cancer cells*. They are round, oval, caudate, spindle-shaped, heart-shaped, according to the pressure to which they have been subjected. They vary in size from the $\frac{1}{1200}$th to $\frac{1}{400}$th of an inch. When young, the cell-wall is smooth and distended; when old, they are more or less corrugated and flaccid. Each cell contains at least one nucleus, sometimes two or more. Such is the microscopic structure of schirrus.

Schirrus is an indolent, hard, and nearly insensible tumour, accompanied with little or no discoloration of the surrounding skin. It commonly commences as a small hard knot in the part which it attacks, and from this minute spot spreads in all directions, like rays from a centre. In this state it has little or no pain, and it may be either distinctly circumscribed and movable, or blended with the surrounding substance, and scarcely at all movable.

As the disease passes from an indolent into a more active state, the size of the tumour enlarges; its surface generally, though not invariably, becomes unequal; pain begins to be felt in it, slight at first, recurring at intervals, and progressively increasing, being always of a shooting or lancinating kind; the skin acquires a purple or livid hue; the cutaneous veins enlarge, become what is termed varicose, and spread out over the livid and puckered skin in such a manner as to present some likeness to the body of a crab with its claws extended, whence it has received the name of cancer. The most characteristic marks of a true schirrus then are puckering of the skin over the tumour, dull leaden colour of the integuments around it, knotted uneven feel of the tumour, and occasional darting pains through it. If to this assemblage of symptoms be added a uniform resistance to all the remedies employed to disperse the tumour, a constantly progressive enlargement of the tumour, and a manifest tendency to involve contiguous parts in the same morbid condition, the evidence of the true nature of the malady will be indubitable.

The rapidity of the progress of a schirrous tumour to open cancer is different in every different case. Sometimes indeed the induration remains in the state of schirrus for many years, and even to the termination of life, the skin never actually breaking. At other times the interval is short from the first discoloration of the skin to its termination in the state of ulceration, or the formation of open cancer.

The carcinomatous ulcer consists of a large chasm formed in the substance of the part in which the malady is seated, the chasm being produced partly by a sloughing and partly by an ulcerating process. The opened tumour is now found to consist of cells; as these cells burst and pour out their contents, which consist of a pulpy matter of different degrees of consistence and of various colours, the surrounding parts are irritated by an excoriating ichor. This discharge sometimes takes place with a celerity which would induce the belief that it can scarcely result from the process of secretion. When the diseased actions have in a manner exhausted themselves, an attempt at reparation appears to take place, analogous to those which in other cases lead to the restoration of a part from a diseased to a healthy state. New flesh is formed, but instead of healthy muscle it consists of a fungus of peculiar hardness, the formative vessels communicating to the new product the same qualities as to the tumour previously generated by their morbid action. This diseased fungus occasionally even cicatrises, and so arrests for a time the progress of the disease. But the morbid action, though mitigated or suspended, is not subdued; it soon recommences its destructive course, and the part never returns to a healthy condition. In the meantime the disease extends through the medium of the absorbing vessels, and by their agency is propagated to parts at a considerable distance from the original tumour.

In the progress of the ulceration a good deal of blood is often lost from the destruction of the coats of the blood vessels. A burning heat is felt universally over the ulcerated surface, the source of unceasing torment. The shooting lancinating pains, sufficiently distressing in the occult state of the disease, now increase both in degree and constancy, and the strongest constitutions ultimately sink under the progressively augmenting irritation and suffering.

When a section is made in a schirrous tumour, in the early stage of its formation, its central portion is found to be more compact and harder than the other parts of its substance. This central portion, which often does not exceed in magnitude the size of a silver penny, is nearly of the consistence of cartilage, and from this centre radiate in all directions, white, firm, ligamentous bands, which are crossed by transverse bands of a somewhat fainter appearance, and in this manner is formed a kind of net work, in the meshes of which the new-formed substance is enclosed.

In an advanced stage of the tumour the whole of the diseased part has a more uniform structure; no central point can be distinguished; and the ligamentous bands which extend in every direction, and which are still very apparent, do not follow any regular course, or at least not distinct enough to be traced.

When the tumour passes into the state of ulceration, the central part of the ulcer consists of a small irregular cavity, which is filled up with a bloody fluid, the edges of the cavity being hard, jagged, and spongy, and exquisitely painful. "Beyond the edges of the cavity there is a radiated appearance of ligamentous bands, diverging towards the circumference; but the tumour nearer the circumference is more compact, and is made up of distinct portions, each of which has a centre, surrounded by ligamentous bands in concentric circles."

Encephaloma also presents a fibrous structure, but it is very loose when compared with that of schirrus. In the harder parts it presents fibres, but in the softer parts no traces of fibres can be found. On cutting into one of these tumours it is found to be more or less mottled with a grayish, pinkish, reddish, yellow, or blackish colour, from varying degrees of vascularity. The reddish forms of these tumours are what is known by the name of *Fungus hæmatoides*. The yellowish forms are dependent on a fatty degeneration of the cancerous matter, whilst the black forms are owing to the growth of black pigment cells. This constitutes the *melanosis* or *melanic cancer* of some authors.

On placing some of the soft cream-like fluid under the microscope, it presents a large number of the cancer-cells, which are mixed with a number of rude cells and granules, compound granular cells, blood corpuscles, and more or less fibres. The cells are often degenerated, presenting crystals of margarine and cholesterine. Sometimes it is mixed with a good deal of calcareous matter.

3. *Colloid cancer* is composed of fibres arranged in such a manner as to form areolæ or loculi which are filled with a gray or amber-coloured glutinous matter, which is sometimes transparent, at others opalescent or semi-opaque. This matter is sometimes found quite structureless, or exhibits only a finely molecular surface. At other times it contains numerous cancer cells. It occurs on free surfaces, as the peritoneum, &c. When collected in masses it has an irregular nodulated aspect.

These three forms of disease occur at all periods of life, attack all organs of the body, and both sexes. They are less frequent in the young than in the aged. Females are more liable to them than males. Schirrus has a tendency to attack the glands of the body, and is especially frequent in the female breast. [BREAST, DISEASES OF.]

The causes which lead to the development of these terrible cells, which when once they have begun to form, go on to form others

till the tissue in which they are developed is destroyed, and the system is worn down by their unnatural growth, are hidden in obscurity. Sometimes a suspicion has been created of inoculation, at other times hereditary tendency seemed to account for it. With regard to the first, the evidence is deficient. With regard to the second, it is shown that only a limited number of cases occur in persons whose parents have had the disease previously. Mr. Paget, in his 'Lectures on Surgical Pathology,' says that in only a sixth of the cases of cancer can there be traced any hereditary transmission. As cancer is not an uncommon disease, a large proportion of these cases may have no relation of transmission, but have occurred independently in people related. The tendency to the transmission of this disease is, under any circumstances, not so great as is usually supposed.

With regard to treatment, this must always be palliative. The disease is necessarily a fatal one, and the presumption always is, in the case of a tumour getting well, that it was not cancer. This ought to put people on their guard against those who pretend to cure cancer. Harmless tumours are always easily cured [TUMOUR], and these are often called cancer, and thus credit is obtained by ignorant or designing men for the cure of this disease. A temporary benefit is sometimes derived from the removal of the tumour. Mr. Paget states that the average duration of life after the appearance of the cancer is 49 months. He then adds, "In 49 cases in which the cancer was once removed by operation, the average duration of life after the first observation of the disease was again something more than 49 months. I believe, therefore, that the removal of the local disease makes no material difference in the *average* duration of life." But, he adds, it appears "probable that the course of the more rapid cases is retarded by operation."

With regard to the treatment, it divides itself into *local* and *general*. The local treatment is directed either to *remove* the disease, or to relieve the pain. The evidence is not more satisfactory of a removal of the disease by escharotics, as caustic potass, chloride of zinc, tannic acid, &c., even when applied after producing incised wounds in the tumour, than in removing by the knife. The relief of pain seems a more rational indication, which may be obtained by the application of hemlock, henbane, opium, chloroform, and other local anæsthetics. The general treatment consists in keeping up the strength of the patient, and procuring freedom from pain, and sleep, by the soporific narcotics.

(Paget, *Lectures on Surgical Pathology;* Bennett, *Clinical Lectures on the Principles and Practice of Medicine.*)

Cancer in the Domesticated Quadrupeds is oftenest observed in the bitch, and every character and stage of it may be satisfactorily traced. A small, hard, insensible, isolated tumour is felt in one of the teats. It seems to give no pain, and causes no kind of inconvenience; it is not larger than a pea, perhaps not of greater size than a millet seed. During many months it seems scarcely or not at all to grow, but it never retrogrades. After an indefinite period of time however it begins evidently and rapidly to increase, and smaller ones may be detected at its base. It then assumes an irregular figure, and the whole, or portions of it, become hard—of a schirrous hardness, and perfectly incompressible; other portions are soft, perhaps hollow, and cellated. At length a portion of the tumour begins to become prominent and soft. It is intensely red, then purple, and after a while it breaks, and discharges a corroding ichorous fluid. The tumour is evidently disorganised deeply within its substance, and a cancerous ulcer, with an irregular elevated edge, is established. Perhaps it heals in the course of eight or ten days, but it soon opens afresh, wider and deeper, and at length the animal is destroyed, either by the general irritation which is established, or by the contamination of the circulating fluids, which are speedily affected by the vitiated secretion of the part.

Iodine, which has so much power in dispersing glandular and many other tumours, is inert, whether applied externally to the cancerous tumour or ulcer, or administered internally, in order to affect the constitution. The excision of the tumour is generally useless after it has acquired any considerable bulk, for it will appear on examination that the constitution is affected, and that the nuclei of other tumours are to be found in the other teats. After the ulcerative process has been once established the case is perfectly hopeless. Even if the nuclei of new enlargements cannot be felt, the animal will nevertheless soon perish from the development of the disease internally, or, to speak more properly, from metastasis of the disease.

The only effectual mode of treatment is to remove these nuclei as soon as they are perceived, and before the system can be contaminated.

The cause of cancer in these cases is the comparative inactivity of certain parts, which nature intended to be actively and usefully employed. At every period of œstrum in the bitch, there is a secretion of milk in the teats, which not being drawn away in the natural process of suckling, the fluid is long detained in the teats, irritates them by its presence, and produces this specific and fatal inflammation. Hereditary predisposition, over-feeding, and sometimes external violence, are sources of scirrhous tumours.

Cancer is found also in the vagina and uterus of the bitch, and occasionally canker in the ear assumes the character of true cancerous ulcer. All applications and operations are perfectly useless.

In the teats of the cat, cancer establishes itself to an extent that would scarcely be thought credible. The whole of the external surface of the belly often presents one horrible mass of cancerous ulceration.

The horse is subject to cancer in the eye, and the scrotum externally; and the kidney, and the vagina, and the uterus, and particularly the pyloric orifice of the stomach internally. The symptoms by which the presence of internal cancer might be indicated are not known, and if they were, no medical skill could arrest the evil.

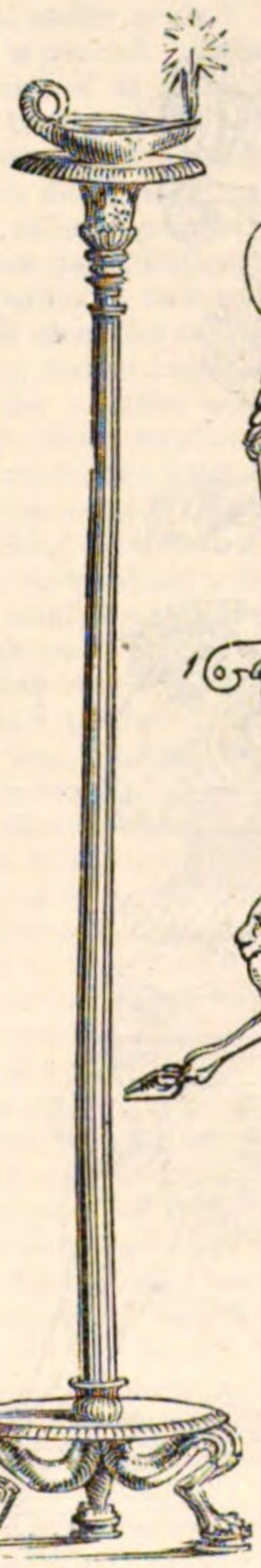
Cattle and sheep are subject to cancer of the jaw, the eye, the scrotum, and the udder externally; and of the pyloric orifice of the fourth stomach internally.

CANCER, the Crab, the fourth constellation of the zodiac, being one of those in Ptolemy. From the end of January to that of April, its time of coming on the meridian in this country varies from midnight to six in the evening. In the obsolete and useless division of the ecliptic into signs, Cancer is the part of that circle between 90° and 120° from the vernal equinox. The surrounding constellations are Hydra, Leo, Lynx, Gemini, and Canis Minor.

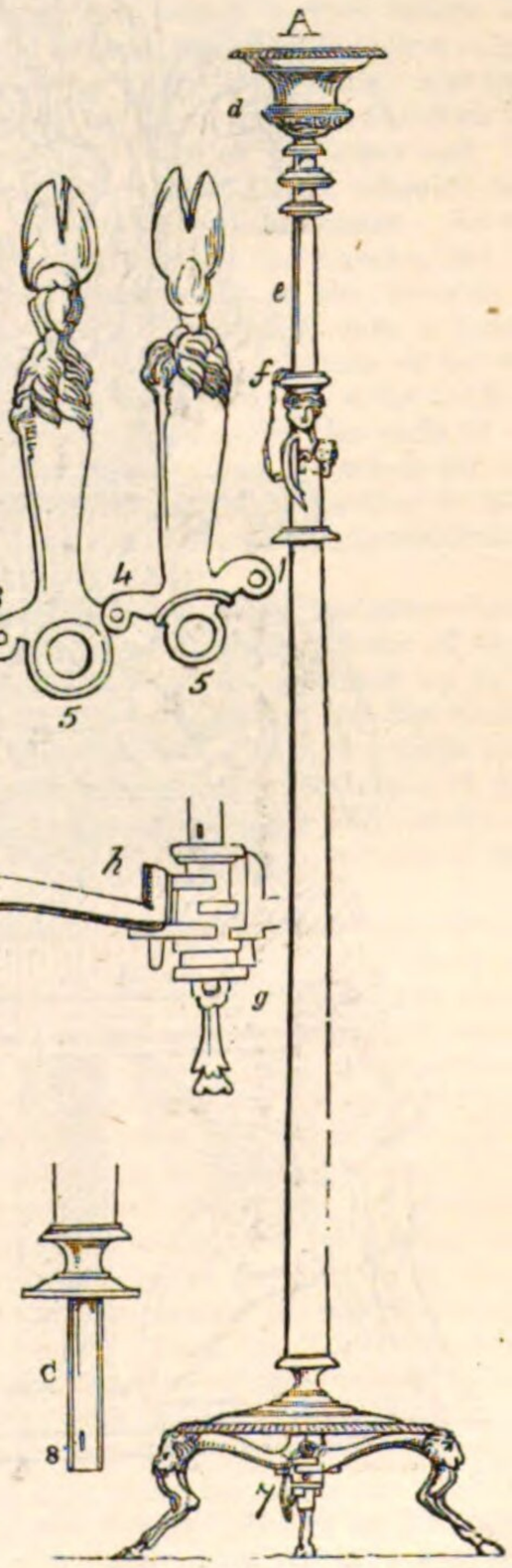
There are edifying mythological stories in Hyginus, &c. [ZODIAC.] The mythology of the minor constellations is hardly worth a reference. There are no stars of conspicuous magnitude in this constellation. The following are the designations of the brightest:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
γ	43	2937	4
δ	47	2953	4
α	65	3055	4

CANDELA'BRUM, an article of furniture used by the ancients both in their public edifices and private dwellings. The candelabra used in public edifices were usually of a greater size, and made with a large cup at the top to receive a lamp or sufficient unctuous material to feed a large flame: they were also employed for burning incense in the temples. Candelabra have been found in the private dwellings discovered at Herculaneum and Pompeii, consisting of tall slender bronze stands, sometimes with a flat circular top. In other instances



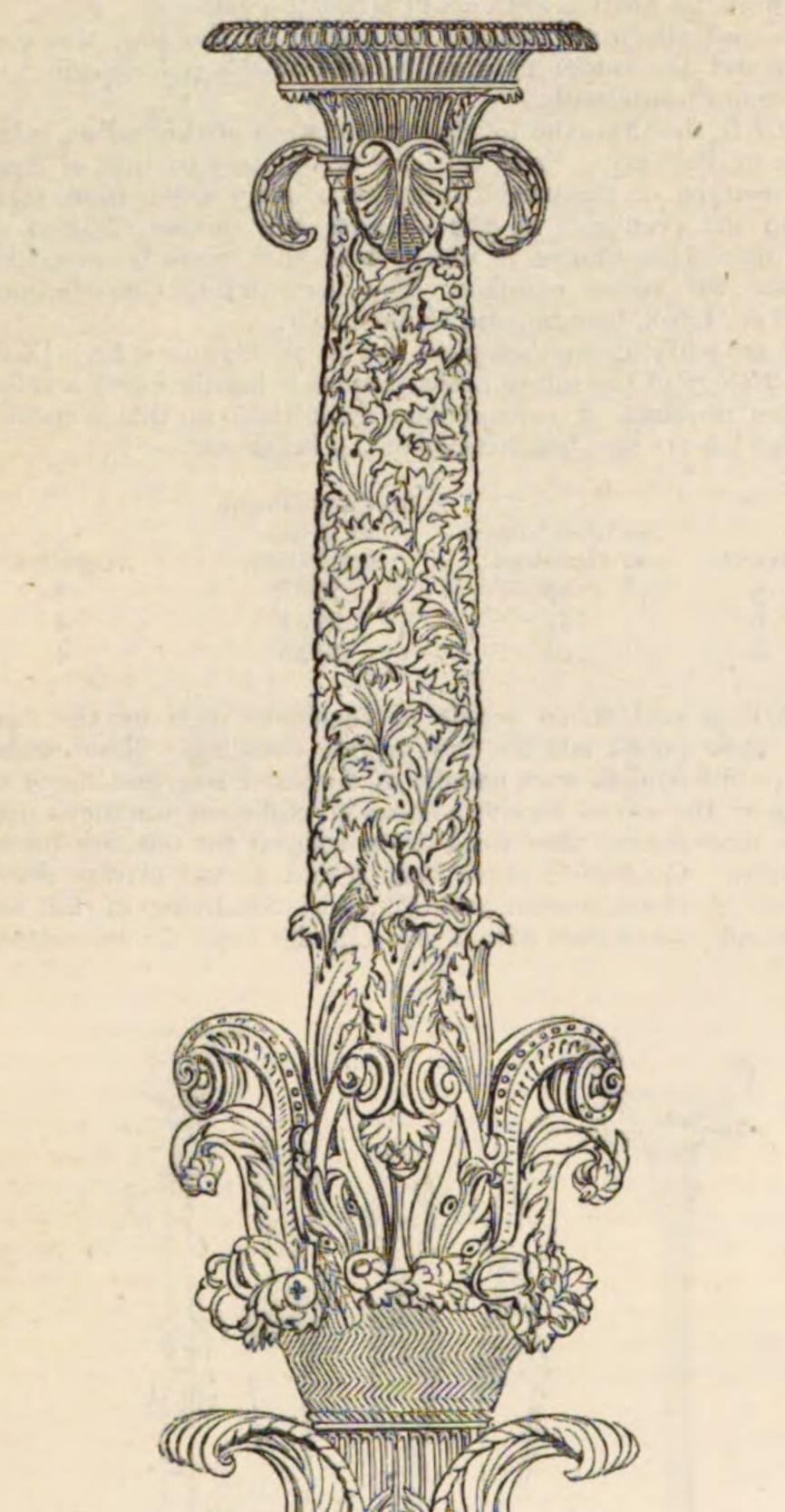
[Bronze Candelabrum from Herculaneum.]



[A, moveable Candelabrum; C, moveable shaft; 1 1, connecting joints of the legs.]

they have a vase-like top, also flat, or with a socket, and projecting feet at the bottom of the long stem on which the light was placed.

The base is usually triangular, with the foot of a goat, lion, or griffin at each angle; and the shaft terminates in a capital which supports the tray or socket. The flat part at the top was called by the Greeks *pinakion*, or "little tablet" (Πινάκιον or Πινακίδιον). Candelabra were among the richest ornaments of public and private buildings. They were constructed of bronze, iron, marble, terra-cotta, and wood; but



[Marble Candelabrum, from Piranesi's works.]

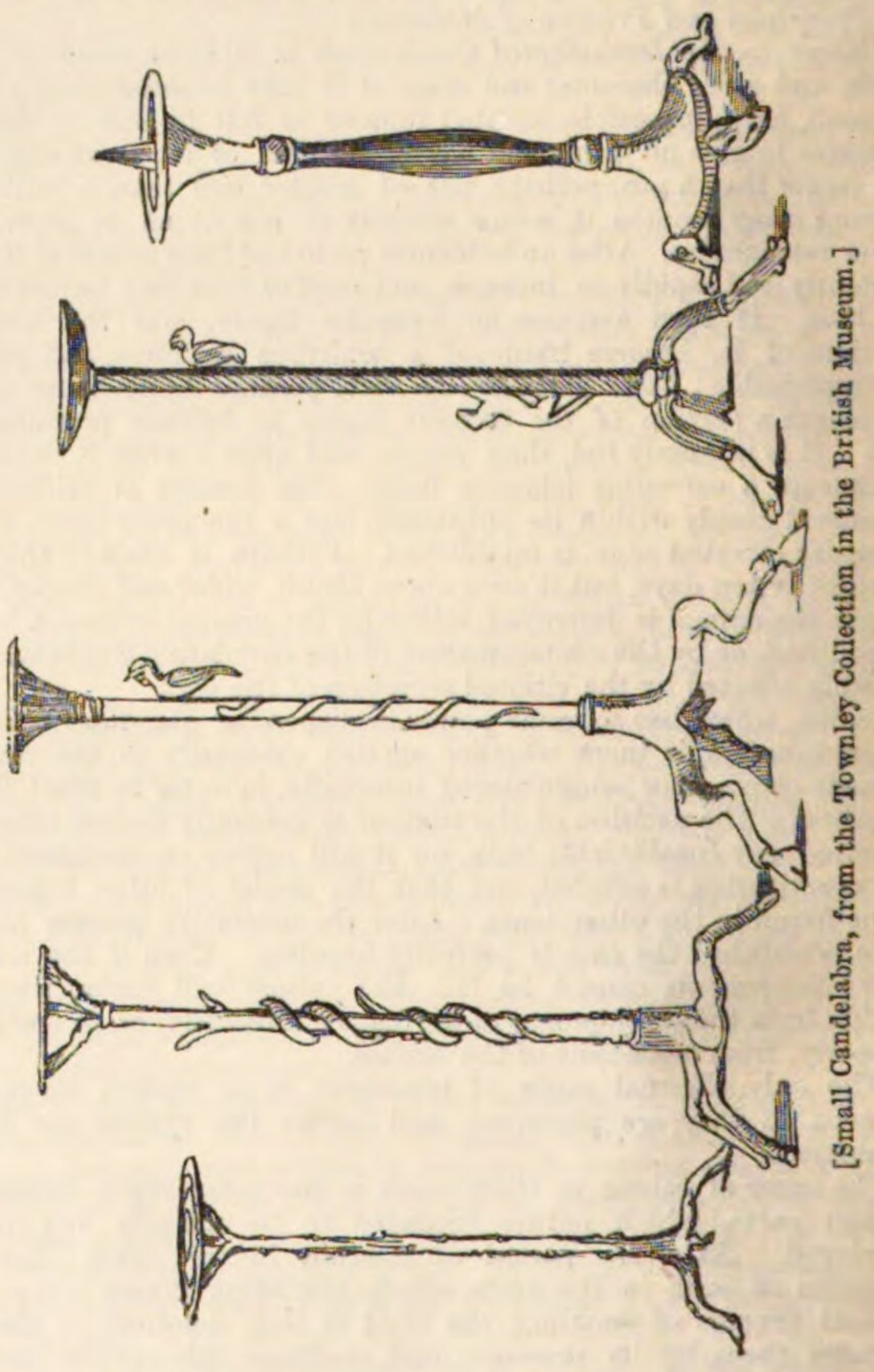
some are mentioned as being made (or covered) with the precious metals. Their forms were varied in all possible ways to please the taste of the wealthy: sometimes the stand was a human figure,

holding in one hand the cup or receptacle of the oil, and ornamented with gilding:—

> "Si non aurea sunt juvenum simulacra per aedeis
> Lampadas igniferas manibus retinentia dextris,
> Lumina nocturnis epulis ut suppeditentur."
> (Lucretius, ii. 24.)

These candelabra or lamp-stands "in their original and simple form, were probably mere reeds or straight sticks fixed upon a foot by peasants to raise their light to a convenient height. . . . Sometimes the stem is represented as throwing out buds; sometimes it is a stick, the side branches of which have been roughly lopped off, leaving projections where they grew. . . . Some have a sliding shaft, like that of a music stand, by which the light might be raised or lowered at pleasure." The annexed cut represents two bronze candelabra, one of a simple form, the other in some measure complicated. "The base is formed of three goats' legs, each having a ring at each end, 5, 5, 5. The centre piece is attached to the side pieces by rivets, 3, 4, round which these rings are allowed to turn, so that the three lie either parallel when the candelabrum is taken to pieces, or may be made to stand at equal distances in the circumference of a circle, in which case the two exterior rings lap over each other, and are united by a moveable pin. The end rings, 5, 5, 5, which are placed at different heights as shown at *h*, will then be brought into the same vertical line; and the round pin, *c*, which terminates the stem, passes through them and is secured by a pin, 7, passing through the hole, 8, which keeps the whole tight." The shaft is square and hollow, and surmounted by two busts. Within this lower shaft a smaller shaft, *e*, plays up and down, and is fixed at any desired height by the pin, *f*. ('Library of Entertaining Knowledge'—'Pompeii,' vol. ii. pp. 295-6.) According to Pliny ('Nat. Hist.' xxxiv. 6) the finest candelabra were made at Tarentum and Ægina.

The annexed cut of a marble candelabrum is from Piranesi's work, 'Vasi, Candelabri, Urne, Tripodi, ed altri Ornamenti Antichi,' 2 vols. fol. atl., Romæ, 1778. In these works excessive richness in the design and delicacy in the execution are often combined. Two exquisite works of candelabra, carved in marble, are preserved in the Radcliffe Library, Oxford. The fragments of which they are composed were found in the villa of Hadrian at Tivoli, and were presented to the university of Oxford by Sir Roger Newdigate.



[Small Candelabra, from the Townley Collection in the British Museum.]

It appears that a smaller kind of candelabrum was used as an altar. (See bas-relief engraved in the 'Museo Chiaramonti,' vol. i.; also p. 56, note 24. The plates xxxvii., xxxviii., xxxix., xl., vol. vii., 'Museo Pio Clementino and Chiaramonti,' contain representations of ancient candelabra; see also the dissertation of Ch. Monsignor Gaetano Marini,

'Sopra gli Usi de' Candelabri.') The marble candelabrum in the Townley collection of the British Museum is about four feet high, with a representation of a large flame on the top. In the Townley collection there are also several bronze candelabra from twelve inches in height to upwards of five feet, and of various patterns. They are mostly flat on the top, although some are formed with a cup-like top, as if for a large flame. One has a spike to receive a clay lamp, with a hole in the centre. There is also one formed upon the principle of the lamp represented in the cut, so that it can be raised or lowered at pleasure. In all, there are about seventeen lamps, of which some of the annexed engravings are representations. In the 'Museo Borbonico' are several representations of bronze candelabra found in Herculaneum and Pompeii.

CANDLE MANUFACTURE. Candles are commonly made of tallow; but superior kinds are made of bleached wax, of the purified head-matter of the spermaceti whale, or of a composition of purified tallow and wax. Within the last few years, the concrete matter from which the more fluid portion of the oil of cocoa-nuts has been separated by pressure has been used for making candles; and some manufacturers have separated the fatty from the oily substance of tallow, and have used the former alone, which is called *stearine*, for the purpose. Indeed the careful analysis of tallow and other fatty substances has recently added largely to the list of materials for candles, and to the scale on which the manufacture is conducted, as we shall show further in a later paragraph. The form of a candle is always cylindrical, and a fibrous and combustible substance called a wick always occupies the centre of the cylinder throughout its length.

The process by which light is produced from the combustion of a candle or a lamp is the same in both cases—with this difference, that the solid matter of the candle must be rendered fluid by the heat of the wick previous to its conversion by the continued application of heat into inflammable gas. In all cases the office of the wick is merely mechanical: serving in the first instance by the heat given out during its combustion to fuse that portion of the tallow or wax to which it is more nearly applied, and then to take up through its fibres the fluid matter, which is thus prepared by minute division or separation for decomposition and combustion.

It is essential to the goodness of a candle that the size and substance of the wick should be adapted to the substance of the candle. If the wick be too thin, it will not be capable of absorbing the fused portion of the candle so fast as it is melted, and this unabsorbed portion will consequently run down the side of the candle and be wasted. If, on the other hand, the wick should be too large, perfect combustion will be impeded through the want of air in the middle of the wick, and the melted fatty substance being less completely decomposed will pass off unignited in the form of smoke; in this case, too, the light will be partially impeded by the body of the wick. Candles made of wax and of other matters which fuse less easily than tallow burn longer than tallow candles, and yield a purer and steadier light. The less fusible matter requires a smaller wick to act as its carrier and to place it in circumstances favourable for combustion; and this smaller wick being less capable than the more substantial wick of a tallow candle of supporting its own weight, the extremity falls out of the perpendicular, and being brought into contact with the oxygen of the atmosphere, is consumed. The wick of a wax candle, consequently, requires no snuffing, as that of a tallow candle does, in order to ensure the brilliancy of its flame; neither does it occupy so large a space in the centre of the flame, and thus intercept the rays of light given off during the combustion. In what way modern improvements have rendered possible the manufacture of tallow or common candles which "require no snuffing," will be explained presently.

There are two ways of making candles, which are distinguished as *dipped* or *mould* candles according to the method employed. Dipped candles are made as follows:—Wicks made of spun cotton are selected of a size proper for the intended diameter of the candle, and are cut into the requisite lengths by a simple and convenient machine, being first doubled and twisted so as to leave a loop at one end. Into this loop a smooth cylindrical stick half an inch in diameter and about three feet long is inserted; and several of the cottons or wicks, being so treated and disposed at regular intervals on the sticks, are ready to receive their external coating of tallow. The number of cottons ranged upon each stick varies according to the size of the candles to be made, it being usual to place such a number as, when the requisite quantity of tallow has been attached, will weigh two pounds: that is, if candles, eight of which will weigh a pound, are to be made, sixteen wicks are ranged upon each stick; if six are to make a pound, then twelve wicks are used; and so on. The tallow, being previously melted and strained, is placed in a kind of trough, into which the wicks are dipped three times for the first 'lay;' after being kept a short time over the trough for the wicks to drain, the sticks are placed on a rack from which the candles hang freely, and are thus allowed to harden. The same process is repeated a second and a third time and oftener, according to the required weight of the candles. During the operation the tallow in the trough must be stirred from time to time, and fresh tallow supplied, the whole being kept in a proper state of fluidity by the external application of a brazier or a bath of hot water. In some of the large establishments, the number of candles dipped at once is very considerable. In making (to take an example) the candles called 'twelves,' that is, twelve to the pound, there are in the first place twenty-four wicks hung on each broach or stick; thirty broaches are ranged side by side, and form a group called a 'frame;' and thirty-six of these frames are attached to a machine revolving on a vertical axis. The number altogether thus amounts to 24 × 30 × 36, or 25,920. In front of such a machine is a vessel of melted tallow; the thirty-six frames are each in turn brought round to a position directly over the vessel, and each frame of 480 wicks dipped at once. A 'wiping-board,' is, after each dipping, brought over the cistern by the movement of a lever; the ends of the wicks or candles are wiped on it, and the board rapidly re-ascends to its former position. The mode of determining when the candles have been dipped a sufficient number of times is by the use of a kind of steelyard or balance weight, indicating the total weight of all the candles on the machine. This method of dipping can of course be modified in a great number of ways; but by such a machine as is here described, a man and a boy can make nearly 26,000 'twelves' in ten hours.

Mould candles are made in cylindrical pewter moulds, one end of which is smaller than the other, to allow of the easy removal of the candles. In the simple and smaller mode of conducting this operation, from ten to sixteen of the moulds are placed together in a wooden frame, in such way that their larger ends terminate in a kind of trough common to the whole; the wicks are inserted and kept firmly in their proper places in the centre of each cylinder by strong wires. The frame being then placed with the trough uppermost, the moulds are filled with melted tallow, and are placed in the air to cool; the wires by which the wicks are fixed are then withdrawn, the superfluous tallow is removed from the trough, and the candles are pulled out of the mould.

In Morgan's beautiful mould-candle machine, however, the operations are conducted in a very different manner. The wick, instead of being cut off to the exact length required for each candle, is wound upon a reel in lengths of 100 feet. There are as many of these lengths as there are moulds. In a kind of case are enclosed a certain number of moulds, with a reel of cotton attached to each. A portion of cotton is unwound from each reel, and made to pass through a mould, the lower end of which is only large enough to admit of the passage of the wick, and is held in its place by a pair of forceps. The frame is then brought under a kind of cistern, into which melted tallow of fine quality is poured. By turning a handle, the melted tallow is allowed to flow out of as many little holes as there are moulds; and thus the moulds become filled. As the moulds fill, a man pulls the wick in each mould straight and uniform, by laying hold at the lower end. When one set is filled, the frame which contains them is wheeled along a kind of railway, and another is filled in a similar manner. As soon as the tallow has solidified, a workman disengages the forceps, and scrapes the superfluous tallow from the upper ends of the moulds. The frame is then turned so as to bring the moulds into a horizontal position; and an ingenious piece of mechanism forces all the candles out of the moulds, and places them in a row on a flat table. The wicks in these candles are still connected with the coils of cotton wound round the little reels in the frames; but the whole are severed in a few seconds by the attendant workman. Still further to facilitate the working of this most ingenious machine, all the mould-frames are made to move along a double line of railway.

Wax candles are made by a process much more primitive than any of the above. The wicks being cut and twisted, several of them are suspended over a basin of melted wax; the wax is taken up in a large ladle, and poured from time to time on the top of the wicks; the melted wax, running down, adheres to and covers the wicks throughout their length. This is repeated until a sufficient weight of wax has been gathered upon each. After the candles are sufficiently cooled, they are rolled upon a smooth table in order to give them a perfectly cylindrical form, and are then polished.

Various plans have been proposed to obviate the inconvenience of snuffing tallow candles. One of the most ingenious of them was the subject of a patent in 1799. This plan consisted in making the candle a solid cylinder throughout without any wick in the centre, and applying on the top of the candle a very short wick which acted in the same manner as the short wick of a lamp. Two different methods were employed for keeping this wick in contact with the top of the candle during its combustion. One was to attach the wick to a small metallic frame or ring which was placed round the top of the candle like a collar, and was of such a size as to admit of its moving freely on the candle, so that it sunk in proportion as the matter of the candle was consumed. A cross piece, in the centre of which a socket was made for the insertion of the wick, kept the latter in its proper position, and prevented the undue sinking of the frame. The other method was that of attaching the wick to an immovable vertical rod which formed part of the candlestick, and of keeping the top of the candle in contact with the wick by placing its lower end upon a spiral spring which constantly pressed the candle upward against the frame that contained the wick. It is probable that one principal cause of the failure of these contrivances arose from the nature of the substance of which the candles were made; the unconsumed carbonaceous matter would form a crust upon the wick which would occupy in part the place of the frame, and thus to a considerable degree cause the same inconvenience as the ordinary wick.

The construction of candles requiring no snuffing is, however, now among many novelties successfully practised. These novelties are, indeed, singularly numerous. Patents have been obtained for candles made of palm oil, which is solid in our climate though liquid in Africa. Stearine and margarine are also employed for this purpose. *Palmer's* candles are distinguished chiefly by the use of a wick which, bending out to the hottest part of the flame as it burns, consumes without the necessity of snuffing. But the chief feature in Palmer's patents is the use of a candlestick which maintains the candle always at the same height; there is a spring beneath the candle, which presses it upwards with such force, that the top of the candle is always maintained on a level with the top of the candlestick, the wick alone protruding. A kind of candle lamp was introduced a few years ago, in which solid tallow is placed within a lamp, and melted as it is required for burning. One of the patents obtained by Mr. Palmer relates to several improvements in the manufacture of wicks for candles. The first is the formation of helical or spiral wicks, consisting of a number of strands bound together by cross gymp; with one strand stiffer than the rest, to retain the wick in its proper position. The second form consists of cotton cord, twisted hard and firm. The third is the formation of wicks plaited on a wire, which wire is afterwards withdrawn to leave a space for capillary action of the melted tallow. The fourth is for coating one of the strands of a wick in a metallic envelope, by dipping it in melted bismuth. Another of Palmer's patents relates to the use of a paste of borax, bismuth, flour, and charcoal; when applied to the *sides* of wicks, in a stripe or line, it is said to facilitate combustion, and to cause the wick to burn out of the flame.

Mr. Maudslay has patented a remarkable machine for making candles by a sort of tube-drawing process, something akin to the Italian mode of making maccaroni. The tallow or composition is brought to a soft warm paste-like state, and in that state is forced through a tube kept cold by immersion in water; it gradually solidifies during its passage through the tube (which is of considerable length, and is coiled round a circular vessel), and is discharged into water, where it at once assumes a solid form. At one particular point before the tallow has solidified, an end of cotton wick is introduced into the tube, and is drawn in and enveloped by the tallow as it passes. The theory of the machine is such that it could produce an *endless* candle, which may be cut by simple machinery to any given length. The machine is remarkably novel and ingenious in its arrangements.

The Patent Candle Company's works at Vauxhall and Battersea are interesting, as showing the application of chemistry and of mechanism on a large scale to this manufacture. The cocoa-nut oil is chiefly procured from Ceylon, but the palm-oil (which is the chief ingredient in the patent candles) from Africa. The palm-oil reaches this country in a semi-solid state. It is first liquified by passing a steam-pipe through it; then converted by chemical processes into a colourless concrete mass; and then cut by a rotatory machine into slices, which are placed one upon another, with cocoa-fibre mats between them, and iron plates between the mats. These bundles are taken to a room where are powerful hydraulic presses, worked by steam power; and this immense pressure is applied, first cold and then hot, to force out the oleic acid from the palm-oil, leaving the solid stearine behind. This stearine, after being again liquified, is in a fit state for use in making candles, which is effected by the patent moulding machine. The company spin their own wicks (29 miles of which form the preliminary "cottoning" of one machine), and conduct several other subsidiary arrangements on a large scale. One of the many patented novelties which have been brought forward at the Vauxhall works, is a curious method (introduced in 1856), of casing night-lights with a hard material. Stearic acid and white wax are dissolved in spirits of wine; and the night-lights, or any other kinds of candle, are dipped in the melted composition. They come out with a hard film, which dries at once. Or the solution may be poured into the metal moulds for mould candles, and then quickly emptied out; it leaves a film lining the inner surface of the mould. The different kinds of candles manufactured at the Vauxhall works, chiefly owing to a skilful chemical analysis of various sorts of tallow, fat, and oil, by Mr. G. F. Wilson, are singularly numerous. These celebrated candle-works are probably the most extensive in the world. Besides large establishments at Vauxhall and Battersea, the Company are owners of another near Birkenhead. Mr. G. F. Wilson, manager of the company's works, gave the following account of the working arrangements in 1856. "In the month of October, 1840, from which time I can speak from personal knowledge, we employed 74 men and 10 boys, and manufactured about 20 tons of cocoa-nut candles, value 1590*l.*, and about 12 tons of stearine and composite candles, value 1227*l.*, per month. In the corresponding month of 1855, we employed 1098 men and 1191 boys and girls; and manufactured of stearine and composite candles and night-lights, about 707 tons, value 79,500*l.*, per month." They have, or have had, also establishments in Africa for procuring and preparing the palm-oil.

Candles are occasionally made of such composition as to aid the healing art. The "medicated candles," employed more frequently on the continent than in England, are so prepared as to diffuse the active principle of certain volatile substances through the air of a room; or to act as a fumigator. "Mercurial" candles are made by a combination of sulphuret of mercury with wax; they are burned under a glass funnel, which has an orifice at the top, so shaped as to bring the fumigation to bear on a diseased part.

Without deeming it necessary to describe any of the innumerable forms of candlestick, either as articles of manufacture or as artistic productions, we may say a word concerning the numerous curious little pieces of mechanism patented within the last few years, having for their principal object the mode of adjusting candles in candlesticks. One consists of a candle shade constructed in a circular ring, which ring is suspended from a conical cap resting on the top of the candle; as the candle burns this cap sinks with it, and by that means, the shade maintains a constant level relatively to the flame of the candle. Another little piece of apparatus consists of a wire-frame for supporting a shade, and which is itself supported by having a sort of circular spring hoop, which clasps the candle. Many varieties of wedges and springs have been devised for fixing candles into the candlesticks. An ingenious self-acting extinguisher for candles was invented a few years ago, but we believe not patented. A steel spring clasps the candle firmly within its jaws: and the extinguisher is hinged to the handle of this spring by a bent arm. A wire projects from the arm of the extinguisher, and thrusts into the solid part of the tallow of the candle. When the candle has burned down so as to soften the tallow around the wire, the latter slips aside by being no longer able to maintain its position; and the extinguisher falls over the flame of the candle. By adjusting the wire to any particular distance below the wick, the candle can be extinguished after any pre-arranged lapse of time.

The extent of the candle manufacture in this country is not known, since the removal of the excise duty in 1832; in that year the quantity taxed was about 120 millions of pounds. So far as regards export (chiefly stearine, or hard candles, common candles being ill-fitted for exportation, except to very cold countries), the following figures have been exhibited:—

1856	6,038,881 lbs.
1857	5,605,335 ,,
1858	3,061,761 ,,

The years 1856–7 were, from exceptional circumstances, above the average.

CANDLEMAS, the popular name for the Feast of the Purification of the Virgin Mary, February 2nd, derived from the lights which were then distributed and carried about in procession. These lights, it should seem, were carried more immediately in allusion to the prophetic words of Simeon, who, speaking of the Infant Saviour, presented in the temple at the same time, said he was "a light to lighten the gentiles." Alcuin, 'De Divinis Officiis,' p. 231, says, the candles at the purification were an exchange for the lustration of the pagans. From this ceremony of purification the present religious ceremony of the churching of women after child-birth arose.

'The Doctrine of the Masse Booke,' &c., from Wyttenburge, by Nicholas Dorcaster, 8vo, 1554, preserves the prayer for "the hallowing of candles upon Candlemas Day." The candles, having been sprinkled with holy water, were lighted and distributed. They were considered to possess a virtue sufficiently powerful to frighten away devils, and to be a charm against thunder and lightning. Stow, in his 'Annals,' fol., 1631, p. 595, says, "On the 2nd of February, 1547-8, being the Feast of the Purification of our Lady, commonly called Candlemasse Day, the bearing of candles was left off throughout the whole city of London."

"There is a general tradition," says Sir Thomas Browne ('Vulgar Errors,' book vi. c. 4), "in most parts of Europe, that inferreth the coldness of succeeding winter from the shining of the sun on Candlemas Day." A similar notion still prevails in some parts of this country, though it is rather that the succeeding spring will be a cold one.

Candlemas Day was also called Christ's Presentation, the Holiday of St. Simeon, and, in the North of England, the Wives' Feast Day.

It is stated by the author of the 'English Festyvall,' that the practice was borrowed from a pagan custom at Rome, of bearing lights in honour of the god Mars, and that pope Sergius commanded that, instead of the heathen deity, the same ceremonies and the same day should be consecrated to the Virgin Mary. (Brand's 'Popular Antiquities,' edited by Sir Henry Ellis, 1841; Brady's 'Clavis Calendaria.')

CANDY. A candy is generally a mass of sugar, to which a peculiar quality has been given by boiling with it certain other substances. These substances may be chosen for their taste, their aroma, or their medicinal properties, and may be used in any one of the forms of infusion, decoction, tincture, juice, or powder. In such case, the sweetmeat or confection is allowed to cool into flat cakes, or is cast into moulds. Another form of candy is that in which the vegetable substance, whether a fruit, a peel, or any other, is so treated as to retain its shape, but at the same time to assume a semi-transparent appearance, in consequence of being thoroughly saturated with sugar. In one or other of these forms we find candied almond, angelica, apricot, caraway, citron, figs, ginger, horehound, lemon-peel, orange-peel, orange-flowers, &c. Candied sugar, or sugar-candy, is simply sugar rendered very pure by crystallisation. It is brown, white, or red in colour, according as it is prepared from raw sugar, loaf sugar, or from a syrup coloured by cochineal. Besides being used as a sweetmeat, sugar-candy is useful to keep the throat moist during coughs, and is blown into the eyes as a remedial agent in certain cases.

CANELLA ALBA, a tree growing on the coast of many of the West

India islands, particularly Jamaica, also on stony hills; and in woods of the mainland of South America. It was called by Linnæus, at one time *Laurus Winteranus* ('Spec.,' ed. i. p. 371), and at another *Winteriana Canella* (Lin., 'Sp.' 636). It is referred to a small tribe called *Canelleæ*, related to *Guttiferæ*. The bark of the young branches of this tree, freed from its outer rind, is the *Canella alba* of the shops (called also *Costus dulcis* and *Costus corticosus*, and *Cortex Winteranus spurius*, or False Winter's bark). Owing to its white appearance, it has received the name of white cinnamon, which it also resembles in smell as well as cloves. The whole tree is very aromatic, and when in flower perfumes all the neighbourhood; even the dried flowers, when softened again in warm water, have a fragrant odour, similar to that of musk. The smell of the leaves resembles that of laurel. The bark is brought to Europe in rolls or quills of two or three feet long, or short broken pieces of from a-half to one and a-half inch in diameter, and a half to one and a-half line in thickness. The outer surface is either reddish-yellow or verging to a whitish-yellow; the inner surface smooth, resembling the external in colour. The taste is at first agreeably aromatic, and somewhat bitter; afterwards acrid and peppery.

According to Petroz and Robinet, it contains a very acrid aromatic volatile oil (which Sloane says is heavier than water, Henry and Cartheuser say is lighter, and which is employed for the adulteration of oil of cloves), a bitter extractive, a resin, a sort of manna sugar, called *canellin*, gum, albumen, and starch. It is rarely, if ever, adulterated, but is itself often substituted for the *Drymis Winteri*, or true Winter's bark. The two may be distinguished by the following characters:

Canella Alba.	Winter's Bark.
Of a pale orange or ash colour.	Gray or reddish gray.
Fracture whitish, marbled.	Fracture compact or foliaceous, gray at the circumference, red towards the centre, with a very obvious line of demarcation.
Internal surface covered with a whitish pellicle.	Internal surface of a deep red or black.
Odour agreeable, resembling cloves.	Odour peppery, and, when powdered, turpentine-like.
Taste acrid, bitterish.	Taste sharp, burning, intolerable.
Powder white.	Powder grayish yellow.
Watery infusion pale.	Watery infusion red.

The cold infusion of each, treated with the following re-agents, conduct themselves thus:

	Tincture of Galls.	Muriate of Iron.
Canella Alba.	Slight whitish disturbance.	Brown yellow discolouration.
Drymis Winteri.	No action.	Dark brown discolouration.
	Sulphate of Iron.	**Nitrate of Barytes.**
Canella Alba.	No action.	No action.
Drymis Winteri.	Precipitate.	Precipitate.

Alcohol is the most appropriate menstruum: water takes up the less powerful principles only. As the infusion is not affected by many articles which it is often desirable to give at the same time, it affords an eligible vehicle for these, such as tincture and infusion of galls, lime-water, tartar emetic, and the salts of iron and mercury. It may also be given in powder. From its aromatic properties it is likewise a suitable adjunct to mere bitter infusions, such as those of gentian. In the dyspepsia, attended with constipation, of sedentary people, along with sulphate of iron, aloes, and sulphate of potass, it is a most efficacious medicine. This is an improved form of a powder still popular, properly *Hiera Picra*, corrupted into *Hicry Picry*.

Canella alba is used both by the Caribs and the Negroes in the West Indies as a spice and as a preserve, thought to be useful against scurvy. In Martinique the berries furnish a liqueur much prized.

CANES VENA'TICI, the Hounds, a constellation added by Hevelius, who called the nearest to the pole Asterion, and the other Chara. They are held in a string by Bootes, and are surrounded by Bootes, Coma Berenices, and Ursa Major. [Cor Caroli.]

The following are the designations of the two principal stars in this constellation:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
d	8	4235	4
a	12	4346	2·5

CANG, CANQUE, or KEA, a large wooden collar, used as an instrument of legal punishment by the Chinese. It is a species of walking pillory, fitting close round the neck of the culprit, and of such a weight that he can carry it, though with pain and difficulty. The weight is proportioned to the nature of the offence; but the cang most commonly in use weighs from fifty to sixty pounds. When it is fastened round the neck, long slips of paper are pasted over the two parts of the cang, which opens and shuts like our stocks; on these papers the mandarin puts his seal, so that the parts cannot be separated or the criminal relieved without its being perceived. The crime for which he suffers and the duration of his punishment are then inscribed on the cang in large letters, and the officers of the police parade the criminal through the town, after which he is left exposed in some much-frequented street or square, or at one of the gates of the city. As the cang prevents his making any use of his hands, he must be fed by others. M. Huc, in 'L'Empire Chinois' (Paris, 1854), relates that on one occasion, at Fou-ki-hien, he and his companion found a man suffering under the cang, who implored their forgiveness. They examined the slips of paper, and found he was "condemned to fifteen days of canque, the nights not excepted, for the offence of disrespect towards the strangers of the West;" and they succeeded in procuring his release from a punishment for the offence of calling them by a common nickname, and of which they had been entirely ignorant. The Chinese consider this species of punishment very infamous and degrading. Correct representations of the instrument and the manner in which it is applied are given in Sir George Staunton's account of the Chinese, and in the work of Sir J. F. Davis. The cang, called by them Tahtakulah, was formerly in use among the Turks.

CANIS MAJOR, the Greater Dog, a constellation which contains Sirius, the brightest star in the heavens, called also the Dog Star. To this article we shall refer all historical and mythological information connected with this constellation, it being in fact the star, and not the constellation, about which we shall have to speak.

This constellation is directly found by the bright star Sirius, which is in the continuation of the line drawn through the belt of Orion. The surrounding censtellations are Argo, Monoceros, Orion, Lepus, and Columba Noachi. At the end of January, Sirius is on the meridian at midnight.

The following are the principal stars in this constellation. The letters within parentheses are from Baily's *Flamsteed*:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
ζ	1	2051	3
β	2	2061	2
λ	3	2066	4
α	9	2213	1
ι	20	2274	4
ε	21	2293	3
(σ)	22	2309	4
γ	23	2319	3
δ	25	2345	3
(ϵ^2)	28	2391	3
η	31	2458	4
κ	13	2246	4
o^1	16	2267	4
o^2	24	2318	4

CANIS MINOR, the Lesser Dog, a constellation situated above the Greater Dog, and distinguished by a remarkable star of the first magnitude, Procyon, which see for information connected with the history of this constellation. It may be found in the heavens thus: draw a line through Orion's belt and Sirius; a perpendicular to this line from Sirius upwards will pass through Procyon, which is too large a star to be mistaken. It is also nearly in the line joining Sirius and Pollux, about midway between them.

The following are the principal stars in this constellation:—

Character.	No. in Catalogue of Flamsteed,	No. in Catalogue of British Association.	Magnitude.
β	3	2462	3
α	10	2522	1

CANKER. This term is applied, perhaps not with strict propriety, to a very serious disease of the foot of the horse. The horn having been separated from the sensitive portion of the foot, a fungous substance is produced instead of new and healthy horn. The treatment, however, is exceedingly simple. Every portion of horn that has begun to detach itself must be removed. Some superficial caustic must then be applied in sufficient quantity to repress the growth of the fungus, and to rouse the exposed surface to healthy action, but not to eat into and corrode the foot. The butyr (protochloride) of antimony is the best agent for accomplishing these purposes; for, being speedily decomposed by the moisture of the part, it can only act as a superficial caustic. The fungus having been repressed, the Friar's Balsam may succeed as a mild stimulant to the secretion of good horn. No ointment should touch the cankered foot; but pledgets of soft and clean tow should be placed over the sore, and bound firmly upon it, making as equable a pressure on every part of it as can possibly be effected. The foot should be dressed at least once in every day, and kept as dry as circumstances will allow.

Inflammation of the internal part of the ear of the dog will sometimes produce a fungous ulceration, to which also the term *canker* has been applied. A dog may be observed to be continually shaking his head, or scratching his ear, or carrying his head on one side. If the part is examined, some degree of redness or enlargement of the irregular projections on the inside of the ear will be seen. This will generally yield to a few washings with warm soap and water; but should actual ulceration have commenced, a drachm of the extract of lead should be added to half a pint of a decoction of the heads of white poppies, and this substituted for the soap and water. The

inflammation beginning to subside, a scruple of alum should be added to this lotion, in order to dry up the ulcer; but nothing stronger than this should ever be applied, and even the alum should be cautiously added, in proportion as the dog is able to bear it. Purging and alterative medicines will be useful auxiliaries.

If the case is obstinate, and the ear begins to be extensively ulcerated, and the ulcer spreads over the flap of the ear, a seton should be inserted in the poll precisely between the ears, and extending from ear to ear. All water-dogs are particularly liable to this species of canker.

There is another variety of canker belonging to the flap of the ear, to which the hound and the pointer are especially subject. It is either the consequence of that which has just been described, or exists independently of it. A sore appears on the edge of the flap of the ear of a true cankerous nature, and corrodes the very cartilage. The treatment of this also is simple and effectual. The ears, or at least the diseased ear, must be confined by a cap of leather or strong calico, for while the dog can flap and beat his ear, it is evident that the sore can never heal. This being contrived, a strong ointment of alum or white vitriol (sulphate of zinc), or both combined, should be well rubbed on the sore morning and night. The simple alum ointment should first be tried.

Sportsmen too often *round* the ears of the dog; that is, they cut off the diseased parts. This disfigures the animal, and is rarely effectual. Either a new ulcerative inflammation is set up by the operation, or the whole ear having been inoculated and empoisoned by the discharge from the old wound, the peculiar ulcer of canker speedily appears again as extensive and as obstinate as before.

CANNABIN. This name has been given to a resinous substance of unknown composition, extracted from hemp. It is highly poisonous.

CANNIBALS, *Anthropophagi*, or men-eaters. In the Odyssey of Homer we have the story of Polyphemus devouring human flesh; and in Herodotus, the Massagetæ (i. 216) are said to eat their aged parents. The Padæi of India (Herod. iii. 99) were in the habit of killing and eating their relations when they fell ill; a story which some would reject with as little show of reason as others would believe it. Modern facts, the truth of which is put beyond all doubt, confirm the statements of Herodotus. Among the ancient Tupís of Brazil, when the Pajé (chief) despaired of a sick man's recovery, he was by his advice put to death and devoured. (Dr. Martius in 'London Geog. Journal,' ii. 199.) Herodotus (iv. 26) also says that among the Issedones, when a man's father dies, his relations come and help to eat the dead man, whose flesh they render more palatable by mixing it with that of some animal. That these facts as to cannibalism, as reported by ancient writers, are not to be hastily rejected, need hardly be remarked.

In the middle ages, it is true, these stories of cannibalism were wonderfully enlarged, and people who had not yet embraced Christianity were pretty generally set down as anthropophagi. When the Lombards invaded Italy at the end of the 6th century, it was reported of them that they ate human flesh; and a century later the same aspersions were cast on the Slavonian tribes. It became the fashion to bandy the accusation between enemies; thus, during the Crusades, the Saracens said the Christians ate human flesh, as well as the unclean flesh of swine, while the Christians on their side maintained that the Saracens ate men, women, and children, and were particularly fond of a sucking Christian babe torn fresh from the breast of its mother. The giants and ogres of our nursery tales are only the Saracens of the holy wars seen through the magnifying glasses of tradition and romance.

It does not much surprise us that in those rude ages men should try to fix a revolting practice on their sworn foes, but we can hardly understand why the minstrels of the Christians should convert their most approved heroes into cannibals, and praise them for the quantity of infidel flesh they devoured. Yet our Richard I. is put in this predicament by the author or authors of the romance of 'Richard Cœur de Lion.' According to the poem, the first symptom of the king's recovery from a dangerous sickness at Acre was a violent longing for pork, and as pork was difficult to procure in a Mohammedan country, his cook dressed him a Turk's head, of which Richard ate with good appetite, and felt himself quite well in consequence. After some more repasts of the same kind, he is made to say:—

> "King Richard shall warrant,
> There is no flesh so nourissant
> Unto an English man,
> Partridge, plover, heron, ne swan,
> Cow ne ox, sheep ne swine,
> As the head of a Sarezyne."

The old travellers abound in stories of cannibalism, which we may almost invariably pronounce to be false. Few persons would now credit that the Indians and Chinese sold human flesh in the market, or that the grand khan of Tartary fattened his astronomers and magicians with the carcases of condemned criminals; but Marco Polo, the Venetian, who resided in China and traversed the Indian seas in the 13th century, in speaking of a people in Sumatra (the Battas), and of the fierce inhabitants of the group of islands called the Andamans, relates no more than has been confirmed by modern travellers.

In the 16th and 17th centuries, the wildest accounts of the natives of the newly-found lands in America, and of places on the African coast recently brought within the range of European commerce, were circulated by ignorant sailors and believed by credulous writers. In many of these cases there was a small matter of truth at the bottom, which was wonderfully magnified by fear and credulity. It was reported, for example, that the Caribbees preferred sucking infants to all other food—that the Peruvians kept mistresses for the purpose of breeding children for their tables, and fattened, killed, and ate these women when they were past child-bearing—and, not to mention numerous other instances, that the Anzigas of South Africa exposed human flesh for sale in their shambles, as we do beef and mutton. The industrious old compiler, Purchas, says he was assured of the last-mentioned fact "by John Battell, of Essex, a near neighbour of mine, and a man worthy of credit." Even in modern times, the inhabitants of Van Diemen's Land have been set down as cannibals, in Dentrecasteaux's Voyage, because the bones of a kangaroo were mistaken for those of a young girl. Mr. Kane, who recently resided some time among the Indian tribes of Canada, speaks of particular families in several tribes as being confirmed cannibals. But he says these Weendigoes, "eaters of human flesh," as they are called, are always made to encamp apart from the main body of the tribe, though they are treated with respect and a sort of reverence. With them, as far as he could ascertain, the practice always originated in extreme hunger; but it was believed that the taste once acquired the Weendigo was afterwards wholly unable to resist its indulgence. (Kane, 'Wanderings of an Artist among the Indians of North America,' Lond. 1859.) This is the most recent testimony to the prevalence of cannibalism.

Many persons, who admit that human flesh has been eaten under the pressure of necessity, as in sieges, shipwrecks, &c., still maintain that there is no evidence of any race or people eating human flesh from choice. But proof the most conclusive has been brought against the New Zealanders, who devoured their captives taken in war in the most open manner. It is also stated on good authority that even the New Zealanders who had been humanised by intercourse with Europeans and their voyages in European ships, resumed their habits of man-eating as soon as they returned home. That the horrid practice lasted long in New Zealand is proved by a captain in the French navy, who stayed some months at the island. (See 'Voyage de la Favorite, de l'année 1830 à 1833,' par M. Laplace.) The practice has now become obsolete.

The Battas of Sumatra are undoubted cannibals, and there are still native tribes in Guiana, in South America, who fatten and eat their prisoners. ('London Geog. Jour.,' vol. ii. p. 70; but compare vol. ii. p. 240.)

We refrain from offering any conjecture as to the origin of cannibalism. No explanation we have seen appears to us satisfactory.

CANNON, the generic term for large guns. Under this head will be described the method of making cannon in the foundry. Cannon were originally composed of strips of metal bound round and kept together with iron rings; to this succeeded the improvement of casting them in one piece, which was done at first by casting them hollow by means of a core. [ARTILLERY.] At the beginning of the 18th century it was a debated question among several artillerists, whether cannon should be cast hollow or solid. In 1749 a founder of Geneva, of the name of Maritz, informed the court of France that he had discovered a method of boring guns and mortars that had been cast solid; he was at once employed, and worked first at Lyon and then at Strasburg, and the guns were considered very satisfactory, so much so, indeed, that from that time guns have usually been cast solid, and afterwards bored. In casting guns hollow, it was found that they were much weaker in some parts than in others, in consequence of the irregularity of the cooling of the metal; whereas, when they are cast solid, the outside, which cools first, has a much closer and sounder grain, and the centre, which is afterwards bored out, is unequal and spongy in parts.

Cast-iron ordnance for the government in England is principally made at private foundries by contract; the Low-Moor Company, whose works are at Blackford, in Yorkshire, and the Messrs. Walker, of the Gospel Oak Foundry, in Staffordshire, being the principal contractors. Within the last few years an iron foundry has been established in the arsenal at Woolwich, from which a few guns are turned out, principally as a check on private manufacturers, and to avoid the necessity of government being wholly dependent on them.

The usual method of casting iron ordnance is this: A model representing in form, but a little larger than the piece, is made in some hard, well-seasoned wood, or else of cast-iron; the muzzle of the gun, or rather model, is continued for some feet by a solid cylinder, to form in the mould the portion for the dead-head, a waste portion, which is afterwards turned off, and is only added to ensure the whole of the metal of the gun being solid and good, and to supply the shrinkage when cooling, which is generally about ·08 inch for each foot in length. A jacket or box is employed to form the mould in; this jacket is divided into about six parts in its length, each part being again divided into two parts, with flanges on each side, to connect them together by screws and nuts. The mould itself, which is composed of sand and clay-water, is made by commencing with the breach, the model of which is placed on a board, and covered with charcoal-dust and clay-water, to prevent its adhering to the mould, the jacket is then nicely adjusted at the proper distance from the model, and the interstice filled by ramming in sand and clay-water; the next piece is then put on, the jacket adjusted and filled as before, and so on till

the whole is built up. The portions of the jacket are kept slightly apart when making the mould, in order to allow for the contraction when drying. The mould is then dried gradually in a stove; when dry, the jackets being opened and the model taken out, the portions are taken to the pit, and there carefully put together again in a vertical position. A number of moulds being put up side by side, the intervals are filled in with earth or sand, and channels made to a central basin by which the metal is allowed to run in at the top of the dead-head, to this basin another channel is made from the reverberatory furnace. The metal usually employed in England is a mixture of the different sorts usually known as Nos. 2, 3, and 4 of the best cold-blast iron. To arrive at the right qualities for a gun, which are, hardness combined with toughness and strength, is a delicate operation, and requires great judgment and experience in the mixture of the different qualities of iron. The metal is melted in two or three reverberatory furnaces, according to the number of castings, with the purest description of coal, when the furnaces are tapped, and the metal run into a basin of sand, made close to the moulds, into which, when at the right temperature, it is allowed to run. The casting, after standing for twenty-four hours in the pit, is taken out, and remains for about the same length of time in the jacket, which is then released, and the mould broken off by a few blows of the hammer.

The dead-head is then cut off in a lathe, and the gun taken to the boring bench. If found to be without flaws, and sound, it is then taken to the lathe again, and turned down to its proper dimensions. It is then carefully examined inside and out, and if without faults taken to the machine for turning the trunnions; after which it is vented and finished off, either by filing or turning. The specific gravity of the iron of which guns are made varies from 7·0 to 7·2. To obtain the best quality of iron for guns, about the following proportions of iron ore are generally mixed in the smelting furnace: Black iron ore, 2½; aluminous clay ore, 1½; silicious clay ore, 1½. This gives an iron not nearly so soft and crystalline as the quality known as No. 1, nor so hard and brittle as No. 4, but a mean between them, being a mixture combining some of the qualities of each.

Bronze Ordnance.—All the brass or bronze guns used in the British service are cast at Woolwich, in the foundry in the Royal Arsenal. The metal is an alloy of ten or twelve parts of tin to 100 of copper. Copper of itself, though a very ductile, malleable metal, with great tenacity, has not sufficient hardness to resist the wear and tear and chance of external injury to which a gun is exposed. Though it resists the action of gunpowder better than any other metal, shot would soon indent the bore if it were not hardened with some other metal; and tin, though a softer metal, has the property of hardening it. The specific gravity of bronze gun-metal is from 8·6 to 8·9. Bronze guns, in the same manner as iron ones, are cast solid, and with a large dead-head, by which the whole length of the gun is obtained of sound metal; the dross and impurities rising to the top, and the column of metal, by its weight, assisting to compress the lower portion and supply the shrinkage.

Bronze is not so much used in England as abroad for the manufacture of guns. In France the siege artillery has been formed of bronze on account of its lightness, and perhaps from the difficulty of obtaining good castings with the foreign iron, which, with the exception of Swedish iron, is not adapted for guns. The defect of all iron for guns, and more particularly foreign iron, except the Swedish, which is the best, is its want of elastic work and small sphere of cohesive force. The want of elastic work prevents the particles of metal, when expanded by the charge of powder, returning to their former state; and the smallness of the sphere of cohesive force makes the gun liable to burst when at all strained. The tenacity of cast-iron is influenced by the amount of carbon it contains; and as it is extremely difficult to regulate this quantity, guns, even from the same casting, vary much in their strength. The tenacity of cast iron varies from 6 to 9¾ tons on the square inch, while that of bronze is 15 tons, and the sphere of cohesive force is greater; while its principal defects are its want of hardness, which causes the bore of the gun to lose its shape from the mechanical action of the gas and ball if exposed to continued rapid firing, the bore becoming enlarged and indented, and drooping at the muzzle. They are also likely to suffer from the chemical action of the gas, which has a tendency to separate the metals of the alloy,—an effect which would be increased by the addition of more tin, which, though it would harden the compound, would decrease its tenacity.

The method of forming the model employed in the Royal Arsenal at Woolwich is rather different to that described for iron ordnance. The model is formed on a wooden spindle, of a slightly conical form. This spindle, which is a good deal smaller than the required model, having been well greased to allow of its after withdrawal, is rested in a horizontal position between two supports, and has a cross handle attached to one end to turn it by. The portions of the model formed on the spindle extend from the base ring [ORDNANCE] to the muzzle and part of the dead-head, the rest of the dead-head and breach and cascable being formed separately. Plaited straw is now wound round the spindle, bringing the whole nearly to the size and form of the desired model; the object of the straw is to furnish a key for the model composition to adhere to. The model composition is now put on by hand in a moist state; it consists of sand, loam, and horse-dung,—the horse-dung being added to make it friable when burned. A modelling board, cut out to the profile, so to speak, of the gun, is placed alongside, at the proper distance from the centre of the spindle, which being turned round, the soft composition is cut off to the required shape. Care is taken to ensure a sufficient thickness of composition over the straw, and it is laid on in three coats, each coat being dried by a charcoal fire before the next is put on. The model of the cascable is made in the same manner on an iron spindle, and a wooden patch added at the base ring for the tangent scale. The wooden models of the trunnions are then fixed on by an iron pin, and the vent-patch and dispart, if a howitzer, being added, the model is complete. It is washed over with tan-ash and water, to prevent the adhesion of the mould composition. The mould composition consists of loam, sand, and cow-hair, well mixed together with water; this, first in a wet and then in a drier state, is laid on in coats, which are strengthened with hemp fibres and iron hoops. The vent and dispart patches are removed after the first coat, and the trunnions when the mouldings are finished. After the three coats have been put on, and the mould strengthened with iron bars, the spindle is knocked out, and the straw carefully removed. A wood fire is then made inside, and the model composition becoming quite brittle is easily extracted. The mould of the cascable, prepared in the same way, and the remainder of the dead-head, having been added, the mould is raised vertically in the casting-pit, in the same manner as with iron guns. The metal is melted in a reverberating furnace, and if it be a re-casting, a small quantity, about ·3 per cent. of tin, is added to replace the waste, the whole being kept well stirred with fir-poles. When at the right temperature, it is allowed to run into a channel which communicates with the moulds; and having risen to a certain height (about eight inches), the sluice-gates are opened, and the moulds filled two at a time. After remaining three days in the pit, the moulds are taken up and broken off the casting. From two to three times the quantity of metal actually required for each piece when finished is allowed to make up for dead-head, turning down, &c. The dead-head of a 24-pounder howitzer is about 3½ feet long.

The casting is now taken to the boring department, and the dead-head cut off in a lathe. It is then put in the centering machine, the object of which is to obtain the exact centre or axis of the piece, on which all the other lathe operations depend. The piece is laid horizontally on two saddles; each saddle has a system of three slides moving inwards at a uniform rate on screws of the same pitch, two moving horizontally towards each other, the other vertically upwards. As they move at the same rate, the faces of the slides at each saddle are always tangential to the same circle, the centre of which is a drill which is moveable horizontally. When the faces of the slides all touch the outside of the casting, the drills are moved forward, and the centerings are cut.

The gun is now taken to the second lathe, and being fixed by these centerings, the muzzle and base rings, and two rings, one on each side of the trunnion, are accurately turned. This is an important operation, as on it depends the accuracy of the bore.

The trunnioning machine is now employed. The gun rests between two cones, which run into the centerings, and are moveable horizontally to suit any length of gun, and vertically to raise the gun according to its calibre to the right height for the frames carrying the cutting-tools to work on the trunnions. The frames work in and out opposite to each other, on a bed exactly at right angles to the bed on which the gun rests, and have motion communicated to them by a driving-shaft underneath. When the trunnions have been turned, the portion between the trunnions is removed by a planing-machine, from which the gun is removed to the drilling-frame, where the hole for the tangent scale is drilled, and also that to receive the bushing for the vent. As the bush does not run in vertically to the bore, the gun is tilted up to suit the drill, which acts vertically. The hole thus prepared is tapped, and a bush of pure copper with a vent two-ninths of an inch in diameter is screwed in. Copper is employed in preference to other metals, as it withstands the chemical action of powder best.

The boring is next performed, the muzzle-ring (accurately turned in the second lathe) resting in a V, and the gun receiving motion from the mandrill of the lathe; the boring-bits are fixed to the end of a boring-bar, which has a horizontal self-acting motion, or is driven forward by the hand.

The remaining portions of the outside of the gun having been cleaned off in a turning-lathe, the portions at the shoulders of the trunnions which cannot be touched are removed in the shaping-machine. It is then proved, and the driver sawn off, and the button finished with the hand.

The foregoing description applies only to the manufacture of guns at present in use. With respect to the newly adopted Sir William Armstrong's gun, the manufacture is kept strictly secret, and no precise details can therefore be given. The following account, extracted from the 'Times' of May 14th, 1859, is believed to give an accurate general idea:—

"Two hundred guns are to be made this year by Sir William Armstrong, all of them 9, 12, and 18 pounder field guns, a number quite sufficient to supply all our field artillery batteries. Before long, however, we hope to see guns of 50 cwt. which will throw a 90 lb. or 100 lb. ball a distance of five miles. Each gun is made in about three feet lengths, and on much the same principle as the twisted gun-barrels. Thin bars of the best wrought iron, about two inches broad, are heated to a white heat, and in this state twisted and welded

together in spiral rolls round a steel bar or core, smaller in diameter than the bore of the gun. Over this, when cold, another twist of the same kind is made with the spiral running in a contrary direction, and so until three or four layers have been put on, according to the calibre of the gun and the thickness required; the whole is then reheated and welded together for the last time under the steam hammer. The edges of the three feet lengths are next planed down so as to admit their joining and lapping over; and over these edges are forced on thick wrought iron rings, which, being welded down at a white heat, of course contract so as to make the joint almost stronger than if made in one piece. In the breech an opening is cut down into the chamber; but the breech itself is separate from the gun, and is worked backwards by a powerful screw. When the gun is to be loaded, the breech is worked back, and a wedge-shaped piece, fitting into the opening of the gun, lifted out, but not to admit the introduction of the charge, which is pushed forward with a ramrod at the back, working through the large screw in which the breech turns into the chamber, where the rifling begins. The wedge is then replaced, the breech screwed close by a single turn of a lever handle, and the gun fired. The operation of loading and firing can be performed, we believe, three times in one minute. Apart from the simple but effective mechanism of the breech, the great merit of this gun consists in the manner in which it is formed in spirals of metal bands, which give it such an enormous increase of strength that one-half the thickness of iron can be dispensed with. Thus, an ordinary long 32-pounder weighs 57 cwt., and requires 10 lb. of powder to throw a ball to its utmost effective range, 3000 yards. Sir W. Armstrong's 32-pounder only weighs 26 cwt., and a charge of 5 lb. of powder throws its shot 5½ miles, or nearly 10,000 yards. In a 32-pounder of this latter kind there are no less than 44 rifle grooves, having one pitch in 10 feet, or making one complete twist round the inside in a gun of that length. A greater pitch would no doubt give greater impetus to the shot, but the risk of 'stripping' the lead was so great that it could not be attempted. The shot used are iron and cylindrical, and at first were completely coated over with lead; but this plan has just been altered, and the shot have now only two rings of lead a quarter of an inch thick and an inch and a half broad, one at the shoulder and one at the base of the cone. Both these rings are dovetailed, so to speak, into the iron shot, so as to leave about one-tenth of an inch to fit the rifling. Thus, when the cartridge is ignited, the ball is forced forward from the chamber into the narrow bore, which it fills so closely, being actually too large for it, that there is no windage whatever, and every portion of the explosive force is applied to projecting the ball."

CANON (*κανών*), a rule. The several senses in which this word is used are all derivatives from its first or original sense: and this sense it appears to have acquired, as itself a derivative from *canna* (we use the Latin form, though in fact both *canna* and *canon* are Greek terms transplanted into the Latin language), which signifies a *reed* or *cane*; such a plant as produced straight, round, smooth, and even shoots, adapted to the purpose of a *rule*; or as we say, a *ruler*, used in drawing straight lines. The word *cannon* is the same with *canon*, and is applied to the instrument of war so called on account of its resemblance to a rule. The word canon is used in mathematics and in music; and also to express certain grammatical rules formed by the critics. But it is more particularly appropriated to *rule* in respect of things ecclesiastical, and it is in this application of it that we propose here solely and briefly to treat of it.

If it is asked why *canon* should be used for *rule* especially in things ecclesiastical, we answer that the most probable reason that can now be given is, that the word was so used by St. Paul (Gal. vi. 16). "And as many as walk according to this *rule* (*canon*), peace be on them and mercy, and upon the Israel of God."

The *rule* here spoken of was the Christian rule, the rule or law of the Christian church: and as these rules became explained or amplified in subsequent times by persons deemed of authority in the church, as by popes, bishops, councils, whether general or particular, these new rules or explications of the ancient and fundamental rules of the Christian church were designated by the term *canones* or *canons*. Of these there is a great multitude. Thus they speak of the canons of the Council of Nice, the canons of the Council of Trent, meaning the decisions of those councils on points of doctrine or discipline submitted to them. The *Apostolical canons* are canons which are supposed to have been agreed upon at a very early period in the history of the church. By some learned persons they have been referred even to the times of the Apostles, whence this name.

The collected body of these canons forms what is called *The Canon-Law*, which in other words is the law of the church, that body of injunctions regulating men's private discipline, and their social relations, which originate, not in the conferences and wills of civil authorities or parliaments, but in the deliberations of ecclesiastical courts or ecclesiastical assemblies, the members of which were ecclesiastics, and the precedents on which they acted the decrees of similar assemblies, or of other persons possessing ecclesiastical authority, or finally, of the most sacred authority of all, that of the Apostles and of the Founder of the Christian church. We may here make a slight deviation from our subject to point out the distinction between the canon law and the civil law. The former is already explained. The civil law is the political and municipal law of the Roman empire. When we hear a

person spoken of as doctor of laws, what is meant is, that he is a doctor of both civil and canon law; but the term in Great Britain is now little more than a mere honorary distinction.

Canon is also used for the *rule* of persons who are devoted to a life strictly religious: persons who live according to (religious) rule, such as praying at certain hours, and for a certain length of time, keeping themselves from marriage, eating particular kinds of meat, periodical fastings, and the like. It is applied to the *book* in which the rule was written, and which was read over to such professed persons from time to time; and since in such a book it was not unusual to enter also the names of persons who had been benefactors to the community, which names were recited from time to time with honour, and they were held and reputed to be holy persons or saints (sancti), the entry of such names formed what is meant by *canonisation*, though in later times, when it was found that saints multiplied too fast, when every small religious community added any benefactor to their list, the term became confined to such persons as had their names enrolled in the great imaginary volume of which the head of the church was the sole guardian. It was also applied to *persons* who lived under a rule; as the Augustinian canons, persons who adopted the rule of Saint Augustine. And here the distinction is to be observed of *regular* and *secular canons*. The regular canons were persons who were confined to their own monasteries, where they practised their rule; the secular canons were persons living indeed a religious life, or one according to some prescribed Christian form and order, but who nevertheless mixed more or less with the world, and particularly as discharging the various offices of Christianity for the edification and benefit of the laity. This was the species of canons that are found in the cathedral churches, or in other churches called conventual, as at Southwell in Nottinghamshire, which were all churches of very ancient foundation, the centres of Christianity throughout an extensive district. There they lived a kind of monastic life under the presidency generally of a bishop: but issuing forth from time to time to introduce the light of Christian truth into districts into which it had not before penetrated, or to instruct the persons lately received into the church, and to perform for them the various ordinances of Christianity. As parish churches arose, the necessity for such visits from the canons in the cathedral churches was diminished. But the institution remained: it was spared at the Reformation, and continues to the present day. These canons are sometimes called prebendaries. This arises from their being endowed with land or tithe, as many of them are to a greater or less extent, which endowment is called a prebend. The canons have stalls in the cathedral churches, which are generally called prebendal stalls. They form the chapter in the expression the dean and chapter, and are still nominally what they actually once were, the council of the bishop for the administration of the affairs of his diocese.

From *canon* is formed *canonical*, which occurs in many ecclesiastical terms, as *canonical hours*, *canonical sins*, *canonical punishment*, *canonical letters*, *canonical obedience*, and *canonical scriptures*. These terms require no explanation, except it be to add that the canonical scriptures are the usually received books of the Old and New Testament.

CANON (in mathematics). This word, which signifies a rule, has generally been employed to mean a set of mathematical tables. Thus it was customary to speak of the canon of logarithms, of sines, &c. A collection of formulæ has sometimes been called by the same name, and even any mathematical instrument. (Vitalis, *Lex Math.*)

CANON in music (*κανών*, a *rule*), a composition, generally vocal, sometimes in two, but commonly in more parts, in which, with the exceptions that will be mentioned, precisely the same melody, or subject, is given to every part. Thence the word, from the fact that every part follows the same *rule* or *model*. This melody is sung by each, after the leader, either on the unison, or the octave, or on the fourth and octave, &c., below, the voices severally following or answering each other at the expiration of one or more bars. According to many German and French writers the canon is a *perpetual fugue*, but this definition is liable to great objection: indeed, the term *fugue* is itself by no means satisfactory. [FUGUE.]

To compose a canon on the unison, or octave, requires less labour than genius, and, with very few exceptions, is the only composition of the kind that produces a constantly agreeable effect. A canon is said to be written *three-in-one* (or *four-in-one*, &c.) on the unison, when the parts follow on the same degree of the scale. Cherubini's 'Perfida Clori,' and Dr. Hayes's 'Come follow me to the greenwood tree,' are admirable examples of this sort. The renowned 'Non nobis, Domine,' of Birde is an unrivalled specimen of the canon three-in-one, on the fourth and octave below; and Dr. Blow's 'Gloria Patri' (engraved on his monument in Westminster Abbey), a canon four-in-one, on the fifth, octave, and twelfth below, is entitled to the encomiums that have been bestowed on it.

A canon in many parts may have two or even more melodies. Thus a canon four-in-two is for four voices, two singing one melody, two another, both subjects blending. But the canon takes numerous shapes, which it would be impossible, even if it were desirable to describe in this place. The *Canon by Augmentation* is that in which the notes of the answers are double and quadruple in length as compared with those of the subject. Dr. Cooke's 'Amen' (regularly sung after 'Non nobis' at the Catch-Club) is an ingenious example of this species. The *Canon by Diminution* is exactly the reverse of that by

augmentation. The canon *Recte et Retro* has but one peculiarity, and pretends to only one merit, namely, that it may be sung either forwards or backwards. And here we cannot forbear expressing a regret that any composer of real talent should have exposed himself to the mechanical drudgery of generating such ungrateful offspring as canons, except those in the unison. In schools, as exercises for youth, they may be of some use; but even there, if much importance should be attached to them, the imagination of the student will be in danger of being chilled, and his taste depraved. To reduce art to such rule as canon imposes, is preposterous, for it is impossible to name a single composition of the kind that might not have been improved by a breach of the laws laid down for its formation. Canons in music are what acrostics and *bouts-rimés* are in poetry. Good sense now disdains such laborious trifling in literature; let us hope that it will soon prove as influential in the sister-art.

CANON LAW (adopted from the Greek word *κανών*, signifying a *rule*,) a collection of ecclesiastical constitutions for the regulation of the polity and discipline of the Church of Rome, consisting for the most part of ordinances of œcumenical or general and provincial councils, decrees promulgated by the popes with the sanction of the cardinals, and decretal epistles and bulls of the popes. The origin of the canon law is said to be coeval with the establishment of Christianity under the apostles and their immediate successors, who are supposed to have framed certain rules or canons for the government of the church. These are called the apostolical canons; and they are said to have been drawn up by Clement, bishop of Rome, A.D. 93: they did not, however, appear till the 3rd century, and are now generally treated as the production of that age.

These rules were subsequently enlarged and explained by general councils of the church. The canons of the four councils of Nice, Constantinople, Ephesus, and Chalcedon (which were held at different times in the 4th and 5th centuries), received the sanction of the secular power by a law of the Emperor Justinian. (Novel. 131, cap. 1.) The chapter referred to, after confirming the decrees of the four councils, adds, "we receive the doctrines of the aforesaid holy synods (that is, councils) as the divine Scriptures, and their canons we observe as laws." Collections of these canons were made at an early period. The most remarkable of these collections, and that which seems to have been most generally received, is the Codex Canonum which was compiled by Dionysius Exiguus, a Roman monk, A.D. 520. This body of constitutions, together with the capitularies of Charlemagne and the decrees of the popes from Siricius (A.D. 398) to Anastasius IV. (A.D. 1154), formed the principal part of the canon law until the 12th century. The power of the popes was then rapidly advancing to the height which it afterwards attained, and their jurisdiction being constantly extended by new encroachments, required a uniform system of law for the regulation of their decisions.

This necessity excited the active zeal of the monkish lawyers. After some minor compilations had appeared, a collection of the decrees made by the popes and cardinals was begun by Ivo, bishop of Chartres, in 1114, and perfected by Gratian, a Benedictine monk, in the year 1150, who first reduced these ecclesiastical constitutions into method. The work of Gratian is in three books, arranged and digested into titles and chapters in imitation of the Pandects of Justinian, and is entitled 'Concordia discordantium Canonum,' but it is commonly known by the name of 'Decretum Gratiani.' It comprises a series of canons and other ecclesiastical constitutions from the time of Constantine the Great, at the beginning of the 4th, to that of Pope Alexander III., at the end of the 12th century. The Decretals, which were rescripts or letters of the popes in answer to questions of ecclesiastical matters submitted to them by private persons, and which had the authority of laws, were first published in 1234, in five books, by Raimond de Renafort, chaplain to Pope Gregory IX. This work, which consists almost entirely of rescripts issued by the later popes, especially Alexander III., Innocent III., Honorius III., and Gregory IX. himself, forms the most essential part of the canon law, the Decretum of Gratian being comparatively obsolete. These decretals comprise all the subjects which were in that age within the cognisance of the ecclesiastical courts, as the lives and conversation of the clergy, matrimony and divorces, inquisition of criminal matters, purgation, penance, excommunication, and the like. To these five books of Gregory, Boniface VIII. added a sixth (in 1298), called 'Sextus Decretalium,' or the 'Sext,' which is itself divided into five books, and forms a supplement to the first five books, of which it follows the arrangement. The Sext consists of decisions promulgated after the pontificate of Gregory IX. The Clementines, or Constitutions of Clement V., were published by him in the council of Vienna (in 1308), and were followed (in 1317) by those of his successor, John XXII., called 'Extravagantes Johannis.' To these have since been added some decrees of later popes, arranged in five books after the manner of the 'Sext,' and called 'Extravagantes Communes.' All these together, namely, Gratian's Decree, the Decretals of Gregory IX., the Sext, the Clementines, and the Extravagants of John XXII. and his successors, form what is called the Corpus Juris Canonici, or body of canon law. Besides these the institutes of the canon law were compiled by one John Launcelot, by order of Paul IV., in the 16th century; but it appears from the author's preface, that they were never publicly acknowledged by the popes. And in 1661 was published a collection of the decretals of

different councils, which is to be found in some editions of the Corpus Juris Canonici, but this likewise has never received the sanction of the Holy See. It is to be remarked that the canons of the Roman or Latin churches were never received by the Eastern or Greek Church.

The introduction of this new code into the European commonwealth gave rise to a new class of practitioners, commentators, and judges, almost as numerous as those who had devoted themselves to the study and exposition of the civil law, from which, as from an analogous system of jurisprudence, they looked for aid in all cases of difficulty and doubt. In fact, the two systems of law, though to a certain extent rivals, became so far mutually entwined, that the tribunals of the one were accustomed, wherever their own oracles were silent, to adopt the rules of decision that prevailed in those of the other; thus it became customary for those practising before those tribunals, to assume the degree of "Doctor utriusque juris."

The main object of the canon law was to establish, by means of the legislative authority of the pope, the supremacy of ecclesiastical authority over the temporal power, or at least to assert the total independence of the clergy upon the laity. The positions, that the laws of laymen cannot bind the church to its prejudice, that the constitutions of princes in relation to ecclesiastical matters are of no authority, that subjects owe no allegiance to an excommunicated lord, are among the most prominent doctrines of Gratian's Decretum and the decretals; but the constitutions of Clarendon, promulgated by Henry II., to curb the arrogance of 'A Becket, put an end in England to the claims of the clergy to exemption from secular jurisdiction. We have shown in a former article [BENEFICE] that the encroachments of the church upon temporal rights and authorities were never encouraged in England. The doctrines of passive obedience and non-resistance, so slavishly inculcated by the Decretals, were not likely to be relished by the rude and fierce barons who composed the parliaments of Henry II., Henry III., and Edward I. Accordingly we find that this system of jurisprudence never obtained a firm or extensive footing in this country: and our most eminent lawyers, in all periods of our history, have shown great unwillingness to defer to its authority. It is well observed by Blackstone ('Com.' i. p. 80), that "all the strength that either the papal or imperial laws have obtained in this realm is only because they have been admitted and received by immemorial usage and custom in some particular cases and some particular courts; and then they form a branch of the *leges non scriptæ*, or customary laws; or else, because they are in some other cases introduced by consent of parliament, and then they owe their validity to the *leges scriptæ*, or statute law." There was indeed a kind of national canon law, composed of *legatine* and *provincial* constitutions, adapted to the exigences of the English Church. Of these the former were ecclesiastical laws enacted in national synods held under the cardinals Otho and Othobon, legates from Pope Gregory IX. and Clement IV., in the reign of Henry III. The provincial constitutions were the decrees of provincial synods held under divers archbishops of Canterbury, from Stephen Langton, in the reign of Henry III., to Henry Chichele, in the reign of Henry V., and adopted also by the province of York in the reign of Henry VI. (Blackstone, 'Com.' i. p. 83; Burn's 'Eccl. Law,' preface.)

Previous to the Reformation, the metropolitan of each province had the power of making in convocation such canons as received its sanction; but when the king became the head of the church, it was enacted (25 Hen. VIII. c. 19), that no constitutions or ordinances, provincial or synodal, or any other canons, should be made or promulgated by the clergy without the king's assent and licence (this proviso stands unrepealed, it is therefore not competent to convocation to enact canons independent of the sovereign's permission). The same statute (repealed by 1 Philip & Mary, c. 8, but revived by 1 Eliz. c. 1) also provided that such canons, &c., as had theretofore been made by the clergy of the realm, should be reviewed by the king and certain commissioners to be appointed under the act, but that, till such review should be made, all canons, constitutions, ordinances, and synodals provincial, being then already made and not repugnant to the law of the land or the king's prerogative, should still be used and executed. No such review took place in Henry's time; but the project for the reformation of the canons was revived under Edward VI., and a new code of ecclesiastical law was drawn up under a commission appointed by the crown under the stat. 3 & 4 Edward VI. c. 11, and received the name of Reformatio Legum Ecclesiasticarum; but the confirmation of this was prevented by the premature death of the king.

In 1571, a Latin copy of the Reformatio Legum Ecclesiasticarum was produced in parliament as the model for a code of canon law. It was resolved that it should be translated into English, and referred to a conference of members of the house to be had with the bishops, for the purpose of reforming the ecclesiastical laws, and considering the articles of religion. Archbishop Parker, however, objected to it as omitting the Homilies, and containing no form for the consecration of bishops, and claimed for himself and the bishops, without the intervention of parliament, the sole right to judge of and determine the matter. Some warm discussion took place between him and one of the members of the conference (Wentworth), but the matter was allowed to drop, and the Reformatio Legum Ecclesiasticarum remains only as historically illustrating the principles which actuated the early reformers; but although of no legal authority it is, as observed by

Lord Stowell, "a work of great authority in determining church matters, whatever be its correctness in matters of law." (Hutchins *v.* Denzcloe, 1 Haggard's Consis. Rep. 179.) In 1603, another effort, attended with more success, was made to draw up a form of canons.

James I. empowered by letters patent, directed to the Bishop of London (in consequence of the death of the Archbishop of Canterbury, and his successor not being then appointed), the Bishop and clergy of the province of Canterbury, to agree in convocation upon such canons, &c., as they should think "necessary, fit and convenient, for the honour and service of Almighty God, the good and quiet of the church, and the better government thereof." The result was the canons of 1603, to which the king gave his royal assent "according to the form of a certain statute made on that behalf in the 25th year of King Henry VIII., and by our said Royal and Supreme authority in causes ecclesiastical, to ratify by our letters patent under our Great Seal of England, and to confirm the same." These canons contain for the most part, save where modified or aided by statute, the ecclesiastical law of England; but not having received the sanction of parliament they do not bind the laity, but having received the sanction of the Sovereign, the clergy are amenable to them. (Lord Hardwicke in Middleton *v.* Croft, Strange's Rep. 1056). In 1640, the Archbishop of Canterbury (Laud) produced, to the convocation assembled in St. Paul's, a commission under the Great Seal to enable the two houses to agree upon the explanation or alteration of any canon then in force, or to make such new ones as should be thought convenient for the government of the church. A form of canons was accordingly drawn up and approved by the Privy Council and judges, and adopted by the province of York, but they have not been received as superseding or affecting the canons of 1603. It may be added that the canons of 1603 were framed in Latin, and that the English translation is in some parts not strictly accurate (for example, the 100th). It is somewhat difficult to state with accuracy in what the canon law of England is at this day comprised.

The statute of Henry VIII. admits those canons (albeit of the Romish church) which previous to the passing of that Act had been received and adopted either by the consent of parliament or from *immemorial usage and customs*. Ecclesiastical authorities have received our own domestic canons, chiefly to be found in Lepidwood's 'Provinciale,' and Gibson's 'Codex.' The canons of 1603 stand alone in weight and authority, but they affect the clergy alone. The injunctions of Edward VI. and Elizabeth, together with constitutions of Peckham and other archbishops, although of no great authority, still must not be omitted in a summary of our canon law.

There are two species of courts in England, in which the canon law is under certain restrictions used. 1. The courts of the archbishops and bishops and their derivative officers, usually called in our law courts Christian, *Curiæ Christianitatis*, or ecclesiastical courts. 2. The courts of the two universities. In the first of these, the reception of the canon law is grounded entirely upon custom; but the custom in the case of the universities derives additional support from the acts of parliament which confirm the charters of those bodies. They are all subject to the superintendence and control of the courts of common law, which assume the exclusive right of expounding all statutes relating to the ecclesiastical courts, and will prohibit them from going beyond the prescribed limits of their respective jurisdictions; and from all of them an appeal lies to the king in the last resort.

Before the Reformation, degrees were as frequent in the canon law as in the civil law. Many persons became graduates in both, or *juris utriusque doctores;* and this degree is still common in foreign universities. But Henry VIII., in the 27th year of his reign, issued a mandate to the university of Cambridge, to the effect that no lectures on canon law should be read, and no degrees whatever in that faculty conferred in the university for the future.* It is probable that Oxford received a similar prohibition about the same time, as degrees in canon law have ever since been discontinued in England.

Before we conclude this article, it may be as well to observe that the Decree of Gratian and the Decretals are usually cited not according to book and title, but by reference to the first word of the canon, which renders it necessary for the modern reader to consult the alphabetical list of the canons, in order to find out the book, title, and chapter, under which the canon he wishes to consult is to be found.

CANOPUS, the name of an Egyptian jar of a big-bellied form, with a cover or top representing a human head or that of some animal, and frequently having handles. These vessels are generally made of baked earth, sometimes of alabaster, and even of green basalt, and they are often represented on Egyptian coins: several of the so-called Alexandrine medals have canopi on the reverse. Some have hieroglyphics on them, and are painted and glazed; and they occur so fresh and new in appearance that Belzoni, when one was offered to him for the first time, thought the Arab was attempting to palm upon him a new jar for an ancient one. Bodies of sacred animals are sometimes found in these vessels; and they appear to have been much used in religious ceremonies. Canopus is the Greek form of the name of an Egyptian deity; but that the deity was the same as Cnuph or Cneph, as some have asserted appears, to say the least, very doubtful. Earthen jars of this form seem to have been used for keeping water cool, as they still are in Egypt. The British Museum contains several excellent specimens of these canopi. ('Egyptian Antiquities,' vol. ii.;' 'Description de l'Egypte,' vol. i.; Jablonsky, 'Pantheon Ægypt.,' vol. iii.; Wilkinson, 'Ancient Egyptians,' vol. ii.)

CANO'PUS, a star of the first magnitude, in the rudder of the constellation Argo. In Ptolemy it is κάνωβος (*canóbus*), in Pliny, *canopus*. It does not become visible to any part of the earth higher in latitude than the southern part of the Mediterranean.

Hyginus, the author of a book of gossip about the stars, and Martianus Capella, a poet (cited by Grotius), have stated that Canopus was a star in the constellation Eridanus, which they say was the Nile, and the star was therefore the island of that name. Sir John Hill, a modern Hyginus, author of just such another work, has stated that "some old astronomers" have placed Canopus as above described; and Dr. Hutton, who should not have made an authority of Sir John Hill, has copied his words, and repeated the mistake in his 'Mathematical Dictionary.' It therefore becomes worth while to correct it.

CANOPY, the covering over a niche used in Gothic architecture. Being intended not merely as a covering to protect the statues under them from the weather, but as a mark of distinction also, they were used like a baldachin. Hence, as they afford an opportunity for the display of considerable taste and ingenuity, they are usually elaborately and often very beautifully carved. Canopies are sometimes met with in Norman tombs, &c.; they occur more frequently in first pointed architecture, but they are most freely used in the middle and third pointed or decorated and perpendicular styles of English Gothic. In French Gothic buildings canopies are found of exceeding richness. The various Gothic edifices, and especially the cathedrals, in England present numerous examples of canopies, and they occur frequently, and of the most elaborate kind, on the tombs of our kings and princes, placed horizontally, and therefore in such a situation as clearly shows that they were intended, like a baldachin, to be a mark of honour, and not a mere covering. [BALDACHIN.] The dripstone over a window or door is also called a canopy when enriched.

CANTA'TA, in music (from *cantare*, It. *to sing*), originally signified a short lyric drama, consisting of recitative, airs, duets, and occasionally choruses, the subject of which was sometimes sacred, sometimes pastoral, but more commonly of the erotic kind. The invention of the cantata is generally ascribed to Giacomo Carissimi, pontifical Maestro di Cappella, about the year 1650. The 'May Queen,' by Mr. Sterndale Bennett, is one of the most recent English examples of the cantata in this its complete form; and the 'May Day,' by Mr. Macfarren, is another. Subsequently the cantata assumed a more contracted form, and was written for a single voice. Of the latter kind, the most celebrated are those of Alessandro Scarlatti, Handel, Porpora, Marcello, Pergolesi, &c. Purcell's 'Mad Bess' and 'From Rosie Bowers' are cantatas that far exceed in depth of feeling and richness of harmony any that either preceded or followed them. Dr. Pepusch's 'Alexis,' a lighter composition, is a justly-admired cantata; and Dr. Arne's 'Cymon and Iphigenia,' for simplicity and sweetness of melody, is entitled to our notice.

CANTEEN, a small wooden vessel capable of containing three pints, which is carried by each soldier on the march on foreign service or in the field. The use of them has been some time general in the British army; they are usually made of oak and painted blue. They are slung over the shoulder by a leather strap, and have the number or appellation of the battalion and regiment, and the number or letter of the company to which they belong painted on one side.

Another kind of canteen is a square box fitted up with compartments, in which officers on foreign service pack a variety of articles, such as spirit-bottles, tea and sugar canisters, plates, dishes, knives, forks, glasses, and other requisites for the table.

A canteen is also a place in barracks where a licensed sutler is allowed to sell provisions, liquors, coffee, &c., to non-commissioned officers and privates, and the quarter-master of the regiment is responsible that no irregularity occurs; the sale of wine, beer, or spirits is not allowed except at the canteen, and the quantity sold at one time is regulated by the commanding officer.

CANTHARIDIN. Spanish flies contain a crystalline principle, discovered by Robiquet. In order to isolate it, the flies are to be digested in alcohol; the alcoholic solution is to be evaporated to dryness, and treated with ether, which dissolves the cantharidin, and by spontaneous evaporation deposits it in the state of micaceous particles, which are to be purified from some yellow matter by washing with alcohol.

The properties of cantharidin are—that when pure it is insoluble in water, but very soluble in boiling alcohol, and crystallises from it as the solution cools. It is also very soluble in oils, but neither acetic nor hydrochloric acid dissolves it; it melts when heated, and sublimes without decomposing at a high temperature. It is to this principle that cantharides owe their blistering power. One grain of cantharides, mixed with an ounce of lard, is sufficient to produce a very powerful blistering effect when applied to the skin.

According to Regnault, cantharidin consists of carbon 61·68, hydrogen 6·04, and oxygen 32·28, or $C^{10}H^6O^4$.

CA'NTHARIS OFFICINA'LIS (Geoffroy); *Meloe vesicatorius* (Linnæus); *Lytta vesicatoria* (Fabr.); *Cantharis vesicatoria* (Latreille, and 'London Pharma.' 1851); is extensively employed to produce blisters.

* Stat. Acad. Cantab., p. 137.

The volatile principle which is exhaled by the living insect is so pungent as to cause great inconvenience to those who approach the trees where they alight. They are generally collected during the morning or evening when somewhat torpid, by persons, whose face and hands are protected by coverings, shaking or beating with poles the trees on which the insects are seated. The most common method of killing them is to expose them to the vapour of hot vinegar; they are then dried on hurdles, and put up for use. Turpentine is said to protect them from the attacks of certain small insects, which prey upon particular parts of the dead insects. These insects are, a mite (*Acarus domesticus*), a moth (*Tinea flavifrontella*), and two very small beetles (*Anthrenus muscorum* and *Hoplia farinosa*).

The common blistering fly is sometimes found in Suffolk and Essex. Though bearing the name of Spanish blistering flies, the greatest quantity is obtained from St. Petersburg; and the Russian insects are superior to those from Sicily or France. When good, they are of a shining yellowish-green colour; the odour is strong, virose, disagreeable, resembling that of mice; taste acrid, caustic, urinous. By drying they lose a great portion of their weight; but age does not greatly lessen their active properties if preserved from damp. The worms or insects which attack them feed only on the inert part, and are only so far injurious that they create a quantity of dust which is not vesicant; consequently, where worms are present in large proportion, more of the powder must be employed.

Cantharides, analysed by Robiquet, yielded:—

1. A green, fluid oil, insoluble in water, but soluble in alcohol (inert).
2. A black matter, soluble in water, but not in alcohol (inert).
3. A yellow viscid matter, soluble in water, and in alcohol at the common temperature; which has no vesicating power.
4. A white substance, under the form of small crystalline plates; when pure, insoluble in water; but soluble in that liquid when mixed with the yellow matter; soluble in boiling alcohol, from which it is deposited on cooling in crystalline plates; it is also soluble in fixed oils. To this principle the name of cantharadin has been given; many consider it a kind of animal camphor. It is the vesicating principle of the insect. [Cantharidin.]
5. Another fatty matter, insoluble in alcohol (inert).
6. Phosphate of lime
7. „ magnesia } in the skeleton.
8. A small portion of free acetic acid.
9. A still larger portion of free uric acid.

Possibly other principles exist in them. The odour is due to a volatile oil, which is very pungent, and when it reaches the eyes causes severe ophthalmia.

Cantharidin may be extracted in various ways; but where it is desired for practical purposes to employ cantharidin apart from the other constituents of the fly, turpentine, at the temperature of 212° Fahr., allowed to stand upon a number of the powdered flies, especially the large female flies, will extract it; and the terebinthinate solution may be used as a most efficacious vesicant. Cantharidin is so powerful, that one-hundredth part of a grain applied to the skin will excite vesication. Cantharides are employed both externally and internally; but even when applied externally, should their active principles be absorbed, the same effect will be produced as if taken by the mouth. Applied to the skin, in moderate quantity, the only effect is rubefaction of the part, followed in general by vesicles or blisters, and the secondary effects of counter-irritants on the system at large. Should any of it be absorbed, a specific effect will be exerted on the urino-genital organs, precisely as if administered by the mouth. If a very large quantity be absorbed or introduced into the system by the mouth, or any other channel, such as injection by a vein, a powerful and often dangerous degree of action is exerted on the cerebro-spinal system, giving rise to violent nervous symptoms. The quantity which acts as a poisonous dose varies greatly in different individuals. This difference of degree of action is referable to idiosyncrasy; and while one individual has been sensibly affected by merely smelling the powder, six ounces of the tincture have been taken by another without injury. It is a medicine which requires the utmost circumspection in its administration. Even the process of powdering it should be carried on in such a way as to secure the operator from either inhaling any of the floating particles, or from receiving the volatile principle in his eyes. For internal administration, a solution in alcohol or ether is preferable to the powder, as it can be more perfectly incorporated with any fluid vehicle, and prevented from remaining in contact with the mouth or palate. The cases in which its internal exhibition is necessary or justifiable are very few. In some cases of atony of the bladder its use may be allowed; but it is productive of no benefit in diabetes, and should be avoided. Externally cantharides may be employed in various forms for different purposes, to act as a local stimulant, to cause rubefaction, to produce vesicles and a discharge of fluid, or simply for their secondary effects, which may be either stimulant or sedative, according to circumstances. As a local stimulant, tincture of cantharides is very useful in the languid circulation of the extremities which leads to the formation of chilblains. Cantharides appear to act primarily on the nerves of the part to which they are applied, and afterwards on the vessels. In certain conditions of the nervous system, such as occur in apoplexy and palsy, they do not cause vesicles to arise. To produce a rubefacient action, either a mixture of the tincture with some oleaginous fluid may be applied, or the common blistering plaster may be laid upon the part, and both removed before vesication has occurred. This limited application of so potent an agent is often useful, and in some instances all that can with safety be employed. In the inflammatory complaints of young children or feeble persons, it is necessary to remove the applied substance before vesicles form, otherwise troublesome ulcers and occasionally gangrene ensue; this is particularly apt to follow when measles have preceded the application of a blister. Sometimes the discharge of the serum is as exhausting as blood-letting, and must be avoided by the above precaution. To quiet the irritability of the nervous system of old people, accompanied with restlessness, fidgettiness, and discontent, nothing is more effectual than this limited application of cantharides to the nape of the neck. In many chronic cutaneous diseases, especially of the squamous or scaly, and even of the pustular kind, the repeated application of blisters kept on only for a short period is very advantageous. Nothing will so soon cure (along with proper internal treatment, and attention to diet and regimen) ring-worm of the scalp, as blisters applied alternately with poultices, followed by creosote, so soon as the inflammatory stage is removed. As a general rule, blisters, or the employment of cantharides in any way, are not proper at the commencement of any inflammatory complaint. But after the stage of great vascular excitement is over, and when a failure of the vessels of the parts is likely to take place, blisters are of unquestionable service. Also when diseases are assuming the chronic form, blisters have great power in preventing this, or removing it when it has actually occurred. In deep-seated diseases of the joints or bones, the frequent repetition of small blisters in the neighbourhood of the part is of much utility. They are also of great use in relieving pain of the chest in the latter stages of phthisis pulmonalis.

In case of an over-dose, it is more easy to say what should not, than to say what should be done. If vomiting has begun, it should be encouraged, and should be caused where it has not commenced, in order to remove the substance from the stomach; but the stomach-pump is inadmissible, owing to the state of the throat and pharynx. Oily fluids are condemned by some, who affirm that even warm water is bad. Venesection may be necessary; but the state of the nervous system is to be kept in view, and the excitement, if any, moderated, or if there be lethargy, the person is to be roused. Camphor is of little use in allaying the strangury, hæmaturia, and other signs of over-action of the kidneys: opiate enemata are most useful against these symptoms.

Several other insects contain cantharidin, such as the *Meloe proscarabæus*, the *Mylabris cichorii*, the *Coccinella septempunctata*, &c. These or others are used in different parts of the world to produce vesications, especially the *Cantharis vitatta*, or potato-fly, and *C. atrata*, both in North America; *C. ruficeps*, in Sumatra and Java; *C. gigas* and *C. violacea*, in the East Indies; *C. atomaria*, in the Brazils; *C. Syriaca*, in Arabia; *Meloe majalis*, *M. proscarabæus*, and *Mylabris cichorii*, in China and East Indies, also *Mylabris trianthemæ*; *M. pustulata*, Cape of Good Hope, used in China; *Lydus trimaculatus*, in the north of Europe.

The old crude method of applying blistering plaster made of the powdered flies is almost entirely exploded. A small portion of linen cloth cut the size and shape of the blister desired is to be dipped in the acetous or terebinthinate solution of cantharides and applied to the spot. Or the portable and clean vesicating paper, or blistering tissue paper are preferable. Chloroform is a good solvent for cantharidin. Very improper uses are occasionally made of cantharides, from which serious injury may result. These are sometimes given or taken from ignorance, but more frequently with a criminal object. Cantharides is an ingredient in a preparation of iron or steel, where its presence is not suspected. Common iron or steel lozenges are safe enough where any preparation of iron is required, but the *aromatic lozenges of steel* contain, besides sulphate of iron, tincture of cantharides—the prolonged or injudicious use of which may have an injurious effect on the kidneys, bladder, &c., not to mention the nervous symptoms cantharides can produce. These nervous symptoms do not always appear immediately; sometimes not for a week or a fortnight, when their cause may not be remembered or suspected.

CANTICLES. [Solomon, The Song of.]

CANTILEVER, a bracket with a projection beyond the line of the supporting wall, considerably in excess of the width of its face. The name is applied utterly irrespective of the nature of the material of which the cantilever is composed. The strength of a cantilever is to be ascertained by considering it as a beam loaded at one end, and having one solid bearing, unless the section should be such as to render it equivalent to a beam supported also by an inclined strut.

CANTO FERMO. [Plain Chant.]

CANTON'S PHOSPHORUS. [Calcium, Sulphide of.]

CANTONMENTS are the dwelling-places occupied by an army during any suspension of active operations in the field [Tactics]: the term, though frequently applied to winter-quarters, particularly designates the more temporary shelter which an army may occasionally take; for example, during a season of excessive heat. The troops are distributed in villages, houses, &c., as when in winter-quarters, but they are made to occupy a smaller extent of country, and hold themselves in readiness to take the field at a moment's warning.

CANVAS, is a plain, woven material, usually made of hemp, sometimes of flax, sometimes of a mixture of both, and occasionally of less-known fibrous substances. It is a coarse and strong fabric, used for sails, sacks, floor-cloth, tents, &c. All that need be stated concerning its manufacture will be found under FLOOR-CLOTH; SAIL-MAKING; WEAVING.

CANZONET', in music (*canzonetta*, Italian, a diminutive of *canzone*, or *canzona*, a song), a short song, one that is brief compared with the sacred airs of the oratorio, or with the *arie* of the Italian opera. Formerly the term was applied to vocal music in parts; now it is confined to songs for a single voice.

CAOUTCHEN. [CAOUTCHOUC.]

CAOUTCHIN. [CAOUTCHOUC.]

CAOUTCHOUC (India-rubber, Gum-elastic) is the dried milky sap of various plants. [INDIA-RUBBER, in NAT. HIST. DIV.] The fresh juice of the India-rubber tree in appearance closely resembles cow's milk; its taste is also somewhat similar, and it may be drunk without producing any marked injurious effect. It has an acid reaction. Allowed to stand for some time, it separates into two portions. Exposed under the microscope, it is seen to consist of a number of small globules, floating in a clear aqueous fluid; the globules are the caoutchouc, and form thirty to forty per cent. of the fresh juice.

Caoutchouc may be obtained in a pure state by frequently washing the sap with water, or by dissolving the common gum in chloroform, precipitating with alcohol, and drying at a temperature of 70° or 80°. It then has the appearance of gum arabic. Its ultimate principles are carbon and hydrogen, in the proportion of 87·2 of the former to 12·8 of the latter ($=C_8H_7$).

Caoutchouc has been known in Europe but little more than a century. As it occurs in commerce it is of a brownish colour, and has neither taste nor odour. Specific gravity ·920 to ·960. It is unaltered by exposure to the air; is soft, flexible, and very elastic. It burns readily, giving off much smoke. According to M. Payen, it is mainly composed of two proximate principles. One, forming thirty to forty per cent., perfectly taken up when caoutchouc is digested in solvents; the other, fifty to sixty per cent., only slightly soluble, but becoming very much swollen under their influence, owing to the penetration of the solution into the numerous pores which, under the microscope, are seen to traverse caoutchouc in every direction. By carefully renewing the solvent several times, these two principles may be separated from each other; in its highly extended state, however, the slightest agitation breaks up the insoluble one. It is in this way that ether, benzole [MARINE GLUE], bisulphide of carbon, oil of turpentine, and other essential oils, act upon caoutchouc. This porosity also explains the cause of the increase in volume and weight that caoutchouc undergoes when immersed in water, alcohol, and other liquids that exert no chemical action whatever upon it. The soluble principle is softer, less coloured, and much more adhesive than the insoluble portion, the latter however is much superior in tenacity and elasticity. The best solvent for caoutchouc is a mixture of six or eight parts of absolute alcohol with one hundred parts of bisulphide of carbon. Concentrated sulphuric or nitric acids slowly attack and decompose caoutchouc; beyond this it is unaffected by acids, alkalies, chlorine, or chemical agents generally; properties which render it almost invaluable for many purposes in the arts.

When caoutchouc is heated it soon softens, and at about 250° melts into a liquid having the consistence of tar. It does not solidify on cooling, but remains fluid for many months. In this state it forms an excellent lute for pneumatic apparatus; spread over a cork or stopper, it effectually prevents the escape of gases or liquids. Heated to near 600° caoutchouc boils, the greater part being converted into vapour, which by proper refrigerating apparatus may be condensed into a liquid having powerful solvent properties. By repeated rectification it may be obtained colourless. It rapidly dissolves, without the aid of heat, caoutchouc, copal, and the varnish resins generally. The boiling point of this liquid varies extremely. By the aid of freezing mixtures, a portion may be obtained which boils at about the freezing point of water. Specific gravity at 25° is ·630. A large quantity distils over between 280° and 390°, and this, by repeated fractionation and purification, assumes a tolerably constant boiling point of 340°. Amongst these liquids *tetrylen*, *caoutchen*, and *eupion* seem to be present.

Caoutchin ($C_{20}H_6$) is the name given to the substance just mentioned. Its specific gravity is ·842. Vapour density 4·461.

It is almost insoluble in water, and miscible in all proportions with alcohol, ether, and the fixed and essential oils. It combines with hydrochloric and hydrobromic acids, and is resinified by peroxide of hydrogen.

When a strip of caoutchouc stretched to five times its length is heated to 212° and allowed to cool slowly, it does not again contract. Advantage is taken of this fact in the manufacture of elastic cloth. A strip a foot long will thus by six successive operations yield a thread 15,625 feet in length.

Vulcanised India-rubber is obtained by causing sulphur to combine with caoutchouc. This may be done by triturating the latter, softened by digestion in naphtha, with ten to twenty per cent. of sulphur, and heating the mixture to 320°. Another method is by immersing sheets of caoutchouc for two or three hours in melted sulphur at a temperature of 240°, and then heating to 320°, when the vulcanisation immediately takes place. A third process, accomplished without the aid of heat, consists in dipping the caoutchouc into bisulphide of carbon containing two and a half per cent. of protochloride of sulphur; after remaining in the solution for two or three minutes, it must be taken out and washed with water to remove excess of the chloride. By these processes the caoutchouc takes up from ten to fifteen per cent. of sulphur, one to two parts being chemically combined with it and the remainder absorbed by its pores. The latter may be removed by caustic alkaline solutions, bisulphide of carbon and other sulphur solvents. It is also gradually eliminated by the continued expansion and contraction which this kind of caoutchouc undergoes in several of its mechanical applications. Another process of vulcanisation, by which the excess of sulphur taken up by the pores is avoided, consists in heating the articles, manufactured of ordinary caoutchouc, for two or three hours in a solution of protosulphide of potassium contained in close vessels at a temperature of 284°. After washing first in alkaline solution and then in water, the objects are found to be very equally and thoroughly sulphurised.

Vulcanised caoutchouc is quite as elastic as the normal substance. Its great advantages over the latter are that it retains its elasticity when subjected to temperatures below the freezing point, and even above the boiling point of water: conditions under which unvulcanised caoutchouc would become in the one case quite hard, in the other soft and adhesive.

CAOUTCHOUC MANUFACTURES. The name *India-rubber* is extensively applied to this substance, and might have been adopted in the present case; but already many of the manufacturers are shortening it into the form of *rubber;* and, for aught we can tell, further changes of designation may take place. We shall therefore adhere to the original name.

Few departments of manufactures have owed more to the ingenious contrivances of one man than that of caoutchouc owes to Mr. Thomas Hancock, who took out his first patent nearly thirty years ago, and has secured more than a dozen patents in all. His name must necessarily be mentioned frequently in any fair account of the progress of this branch of industry, even if he had not been the author of the best extant work on the subject. It will be convenient—referring to the NATURAL HISTORY DIVISION for an account of the growth and early history of this remarkable substance—to commence with the year 1819, and rapidly glance at the chief inventions down to the present time.

1819.—Caoutchouc received its name of India-rubber from its remarkable property of rubbing out pencil-marks; but its elasticity and its imperviousness to moisture were known to the natives of the countries where the tree grows; and it was natural to expect that European and American manufacturers would endeavour to apply the substance in such a way as to render these properties available. Mr. T. Hancock commenced his experiments with the substance in 1819. He felt that one of the important questions to be determined was, whether caoutchouc can be dissolved so as to render it useful in that state. He first began with oil of turpentine, a liquid which is now known to be suitable to the purpose; but his early attempts were unsuccessful.

1820.—Laying aside the solvent operation for a time, Mr. Hancock applied his ingenuity to various modes of cutting the caoutchouc (imported in bottle-shaped masses) into thin pieces, and applying them as elastic additions to various articles of dress. He took out his first patent in 1820, for a method of applying these elastic pieces to glove-wrists, waistcoat-backs, waist-belts, pockets, braces, trouser-straps, gaiter-straps, stockings, garters, riding-belts, stays, boots, shoes, pattens, and clogs. In the articles first manufactured under this patent, the elastic pieces were fastened to the garments by sewing; but the stitches broke away, and the holding was not secure. He therefore made the pieces additionally thick at the edges, and steeped them in hot water, to enable them to resist better the tearing action of the stitches. One of his contrivances was to cut the bottles of caoutchouc into rings, and apply these rings to the tops of gloves and stockings. Another was a mode of joining surfaces by pressure of the caoutchouc under hot water. A third was that of cutting the material into thin slices by a sharp-edged cutter working under cold water. By degrees there accumulated around him a large quantity of fragments of caoutchouc, which he endeavoured to bring into some use; he invented a *masticator*, consisting of a spiked roller working inside a spiked hollow cylinder; the tearing action of this machine, when the roller was made to rotate, gradually made the fragments hot, and combined them all into one mass. This advance was a very important one; the process was not patented, but Mr. Hancock contrived to keep the secret to himself and his workmen during the long period of twelve years: surreptitious imitators were thrown off the right scent by the process being called "pickling."

1821.—The masticating process was exposed to this difficulty: the gum resisted with immense force the tearing action, insomuch that only two ounces at a time could be masticated by the wooden machine first made; but in 1821 an iron machine was made, worked by horse power instead of by a winch, and with it 15 lbs. could be treated at once. It was found, also, that if the caoutchouc were first heated to about 300°, the mastication was more readily performed.

1822.—Improved forms of machine, and improved modes of heating the caoutchouc, enabled the manufacturer to work up a larger and

larger quantity of fragments at once, and to produce a more homogeneous substance. The heating was now effected in metal vessels, surrounded by high-pressure steam. The caoutchouc was made into blocks, which were cut into thin slices by an ingenious but simple apparatus. It was now found that these sheets were soluble in good oil of turpentine, producing a thick liquid, which promised to be of great value in the arts.

1823.—Mr. Hancock procured a patent, in 1823, for a mode of combining caoutchouc with pitch, tar, and other substances, either in the mastication or by means of the solution. The compound was spread out by means of a hot iron protected by a damp cloth, and the sheets thus produced were used as an under-sheathing for ships beneath the copper. This manufacture was taken up by other firms, and many improvements made.

1824.—The easy production of a solution of caoutchouc soon led to important extensions. It was now found that the elastic pieces could be fastened to gloves, &c., by cementing with this solution instead of by sewing. The upper and under-leathers of boots and shoes were rendered waterproof by cementing in this way thin sheets of caoutchouc. Further applications of the caoutchouc, now rendered practicable, were to the edges of 'noiseless' wheels, the surfaces of rollers and cylinders, the cushions of billiard-tables, tubes and pipes, catheters and bougies, gas-bags, experimental balloons, and washers or collars for stop-cocks. Mr. Hancock obtained from America a small quantity of caoutchouc in its liquid or creamy state, and he took out a patent in 1824, for making a kind of artificial leather by its aid; he mixed the cream with felt, carded cotton, hair, hemp, or flax, dried and pressed it, and produced strong and tough sheets of a substance suitable for boot-soles, hose or water-pipes, straps for machines, harness, and other purposes, all waterproof, and free from stickiness of surface. In this year the name of Macintosh came into the trade. Mr. Charles Macintosh, of Glasgow, took out a patent for the double waterproof cloth, which has had such a world-wide reputation. Two layers of cotton or other cloth were cemented together with a solution of caoutchouc, and then pressed so closely and evenly as to preclude the passage of air or water.

1825.—The two inventors, Hancock and Macintosh, entered into a working agreement in 1825, concerning their respective patents. Macintosh made his own particular solutions at Glasgow; Hancock, his in London; a new factory was built at Manchester for the manufacture of waterproof cloth, while Hancock carried on other departments in the metropolis. Captain (afterwards Sir John) Franklin had several boat-coverings, four life preservers, eighteen bags for cork beds, and four pillows, made of Macintosh's waterproof cloth, for one of his Arctic expeditions; and the great service rendered by these articles tended to increase the reputation of the new material. In this year Mr. Hancock obtained another patent for making artificial leather, by using the caoutchouc solution instead of the native cream or sap. He procured flat fleeces of carded cotton wool, and pressed each fleece between two layers of cloth moistened with solution; by varying the process he could produce sheets of any thickness, and any degree of toughness; and they could have other qualities imparted to them by mixing the solution with resin, size, glue, ochre, pumice, or whiting. These sheets of so-called artificial leather came much into use for the backs of cards for carding-cotton, for blankets in calico-printing, for deckel straps in paper-making, and for machine-straps. The double textures, made of two different kinds by Macintosh and Hancock, became extensively manufactured into air-beds, bolsters, pillows, cushions, mattresses, swimming belts, life preservers, and surgical bandages; the outer surfaces were of jean, jeanet, cambric, silk, kid, or morocco; and the hollow spaces within were inflated by means of bellows acting through a valve or stop-cock. Another patent was taken out this year for a mode of applying the caoutchouc solution to ropes and cordage.

1826.—As it was found that tailors either could not or would not make up garments in a proper way from the waterproof cloth, Macintosh and Hancock were driven to take up this department themselves, and to establish shops for the sale of the garments; from this time the use of such garments by travellers and sea-faring men spread very rapidly.

1827.—Many manufacturers had by this time entered the trade, some of them devoting their ingenuity to articles which had not been attempted by Macintosh and Hancock. India-rubber shoes afforded a special example of this kind.

1828.—Hancock next established a working arrangement with a firm at Paris, sending over solution, sheets, workmen, and machinery, and leaving the Parisians to manufacture such articles as seemed most likely to find a market.

1830.—In 1830 Hancock sent an agent out to Para in Brazil, to instruct the natives in the best mode of collecting and shipping the gum in a liquid state; he still hoped to make some useful discoveries and inventions in this direction; but he ultimately found that the solution, as prepared by himself, was more commercially useful than the original sap.

1831.—About this time, the elastic properties of caoutchouc became more than ever valued, by the production of woven goods having caoutchouc either in the warp or weft. For such purposes a compound thread was formed, having a centre or core of caoutchouc, with an envelope of cotton or worsted twisted round it. The method is said to have been first practised at Vienna, from whence it extended to Paris, and thence to this country. The bottle-shaped masses of caoutchouc were, in the first instance, cut up into slips. This used in the first instance to be done by cutting up the bottle with scissors, and then separating the layers of which it is formed; another plan was to soften the bottle, inflate it by a forcing-pump to the requisite degree of thinness, and then cut it; but the method finally employed was to soften the bottle in hot water, cut it into two halves, press it between two iron plates till it assumed a flat form, and cut the discs or pieces thus produced into ribbons, by a cutter working spirally from the circumference of the disc towards the centre. The ribbons so prepared were next cut into filaments or threads of the desired width, by passing them through a machine having a number of cutting edges. The threads were softened in warm water, and stretched by a winding machine to many times their original length; and being kept in that tended state till cool, they did not spring back again when released. They were then attached to a braiding-machine, and sheathed with threads of cotton, silk, linen, or other material. The threads so sheathed were used as 'warp' or long threads, and were woven into the kind of textile fabric required. A heated iron passed over the woven goods caused the caoutchouc to relax, corrugated the sheathing, and gave to the whole a great elasticity and power of yielding without fracture. If the caoutchouc thread were sheathed while in the natural state, it could not afterwards be stretched without breaking the sheathing; and it was for this reason that the sheathing was applied to a stretched thread of the inner material. Sometimes the compound threads sheathed in this way were used as alternate warps only, sometimes both for warp and weft; and various other modifications were adopted according to the purpose to which the woven material was to be applied. Gloves began very soon to be made at Leicester and Nottingham with caoutchouc knitted into the wrist; and stockings with the same material at the top, to serve in lieu of garters.

1833.—By the year 1833 civil engineers and manufacturers had become accustomed to the use of a large number of articles made of caoutchouc, including gas-bags for repairing main-pipes, pump buckets, plug-ball valves, hydraulic ram packing, buffer-rings, cylinders of tubes of various diameters, hose-pipes, machine-bands, fire-engine hose, malting shoes ("anti-grain crushers"), gig spring blocks, &c.

1835.—Steam machinery became now necessary for working up the vast quantity of caoutchouc used at the Manchester factories; and many London firms also carried on the manufacture on a considerable scale. Another patent was obtained by Hancock for improving his air-beds and cushions; by corrugating the outer casing of cotton or canvas, the cushions were rendered more soft, yielding, and elastic. A year or two afterwards he obtained another patent for applying the caoutchouc to cloth in a dough-like state instead of a solution, producing results more useful for certain purposes. And another, by the same indefatigable inventor, bore relation to the production of wide sheets of any length and width; cloth was used, but only to spread the caoutchouc upon, and was susceptible of separation by a preliminary preparation in a particular way.

1840.—By this year the Manchester factory of Messrs. Macintosh and Co., often produced four thousand square yards of waterproof cloth per day, so large was the demand for the various purposes above indicated. Large air-proof vessels, like flat-bottomed boats, were made as substitutes for metal pontoons in military operations. Numerous other uses rendered necessary the means of masticating the caoutchouc more rapidly than ever; and a new masticator was made capable of treating 200 lbs. at once. This quantity was cast into a smooth, solid, homogeneous block, six feet long by one foot wide, and seven inches deep, ready to be cut and shaped into any desired forms.

1841.—About this time Mr. Brockedon devised an ingenious mode of making a substitute for corks, more equable than corks are usually found to be. In the first place, fibres of wool were felted or worked into an oblong rod or solid cylinder; this rod was cut up into pieces the proper lengths for corks, and the corks so made were coated with a thin sheeting of caoutchouc.

1842.—In this year a remarkable and important improvement was made by the admixture of sulphur with caoutchouc. Manufacturers had been much perplexed by three defects in the ordinary gum,—its clammy adhesiveness, its liability to be affected by change of temperature, and its sensitiveness to the effects of oil and grease. Of these, the second is the worst; the substance becoming hardened by cold and relaxed by heat. In 1842, an agent from Mr. Goodyear, an American inventor, brought to England a few specimens of caoutchouc which had been so treated as to lose these defects; he wished to negociate for the sale of his invention; but as the process was kept secret, English manufacturers declined to treat. Mr. Hancock deemed it quite fair, commercially and morally, to try to discover by his own experiments how such an effect could be produced. After much time and trouble, he devised a mode of combining sulphur with caoutchouc, producing a compound possessing very curious and important properties. Mr. Brockedon suggested the name 'vulcanisation' for this process, and hence originated *Vulcanised India Rubber*. Mr. Hancock obtained a patent for this in 1843; and an English patent was also granted to Mr. Goodyear in 1844. The two patents were worked without interruption for eleven years; but in 1855, an action was

tried to determine whether Hancock had stolen Goodyear's idea. Hancock admitted that the specimens sent by Goodyear had suggested to him the expediency of a course of experiments; but contended that the experiments were entirely his own, unaided by any analysis of those specimens; and the decision was given in his favour—confirming the validity of both patents. Many other law-suits have taken place between rival patentees, in relation to this manufacture.

1845.—A patent was granted in this year for a mode of getting rid of the excess of sulphur in vulcanised caoutchouc, by a mode of treating it with a strong hot solution of sulphate of soda or potash; restoring to it the colour and transparency of the original material, without lessening those peculiar properties which the sulphur produces. Blocks and sheets of this extremely tough material began soon to be made for a very varied range of purposes. Twelve-inch cubes were made solid and uniform throughout; and sheets were formed a hundred and fifty feet long by nearly five in width. Mr. Cow, connected with one of the royal dockyards, suggested a very useful application of vulcanised sheets. Whenever a ship requires repair, it generally calls for the troublesome process of dry-docking, to examine the injuries without interference from the water; this dry-docking it was now found might in many such cases be dispensed with, by the use of a ship-sheet, a piece of vulcanised caoutchouc about ten feet square by three-eighths of an inch thick; this was lowered over the side of the vessel, and when properly adjusted, was pressed against the damaged part of the hull so firmly by the action of the sea or river water, as to permit the water *within* the ship to be pumped out, and the damaged place examined.

1846.—By this time, many articles previously made of plain caoutchouc were found to be better if made of the vulcanised material; while new applications were every week devised. The public thus became accustomed to the use of vulcanised caoutchouc for elastic bands, washers and packing for machinery, engine-valves, corrugated sheets for railway purposes, billiard cushions, hose-piping, tubing, surgical bottles, gig- and carriage-springs, hydrostatic bed-covers, sacking for iron bedsteads, solid wheel-tires, buffer-springs, japanned artificial leather, pump buckets, gas holders, buoys, vulcanised thread, trowsers- and vest-straps, swimming belts, socket joints, printers' rollers, boots, overshoes, machinery bands, spherical valves, knee-caps, sheet expanders, baby jumpers, corn protectors, cigar cases and tubes, tobacco pouches, sponge and soap bags, jar covers, conical stoppers, bows for archery, playing balls, horse-shoes, greyhound and sheep stockings, cricket gloves and leggings, waggon and cart covers, rick covers, carriage aprons, knapsacks, canteens and drinking cups, &c. So tough is this material, that Mr. Hancock and Mr. Nasmyth, judging from certain remarkable experiments made by them at Patricroft, believed it might be usefully applied to the hulls of ships to render them shot-proof—a supposition not, so far as we are aware, yet practically tested. Two patents about this time gave a still greater extension to the use of caoutchouc: one was to render it softer than usual, so as to serve as a kind of spongy stuffing; the other was to render it harder than usual, by casting or pressing it upon moulds, and vulcanising it while in that state. The spongy caoutchouc did not find a very wide sphere of usefulness; but the other novelty admitted of very beautiful results in reproductions of chasing, carving, engraving, bas-reliefs, medallions, &c.; and also a very hard material for slabs, bars, tablets, inlaying, door-knobs, combs, knife-handles, carriage panels, and even flutes. Different degrees of elasticity, flexibility, toughness, hardness, and strength could thus be ensured, according as the caoutchouc was vulcanised before or after its fabrication into articles. The harder kind can be turned in a lathe, or have a screw-worm cut in it, as readily as wood; it is indeed strong enough to build houses, ships, and waggons of, if we had any motive to incur the expense.

1851.—By the year of the Great Exhibition, the caoutchouc manufacture had reached a high degree of excellence in England and America. No less than fifty English patents had been procured for the application of vulcanised caoutchouc to various purposes,—the vulcanising itself still being done by or under licence from the firm of Hancock and Macintosh. The Exhibition displayed in a striking way the ingenuity of the Americans in the use of caoutchouc. Many English productions had been prepared under a process patented by Mr. Parkes; he devised a mode of vulcanising thin sheets of caoutchouc very quickly, without the aid of heat, by treating them with a solution of chloride of sulphur in bisulphuret of carbon. Another patent, by Mr. Brockedon and Mr. Hancock, for a mode of combining caoutchouc with gutta-percha, led to the production of many very beautiful articles, thin sheets of this compound material being afterwards vulcanised by Parkes's process. Various inventors had devised modes of producing in caoutchouc some such change as vulcanisation by substances other than sulphur; and thus new useful forms of the gum came into notice, under the names of "galvanised," "mineralised," "metallised," and "thionised" caoutchouc.

1858.—The seven years following the Great Exhibition were marked by a development of all the various modes of employing caoutchouc, and by the invention of many new ones. The patents obtained were not so much for new processes, as for improvements on processes already known. One was for a mode of printing on surfaces of vulcanised caoutchouc, susceptible of subsequent expansion or contraction. Another was for a mode of using up scraps of vulcanised caoutchouc—much more difficult to effect than when the gum is in the unvulcanised state. A third was for a new method of making vulcanised caoutchouc thread; and there were numerous others, which need not be particularised here. Messrs. Silver, at their works at North Woolwich, are endeavouring to render caoutchouc a substitute for gutta-percha as an insulating covering for telegraph wires.

The importation of caoutchouc, as may be supposed from the above details, has rapidly and largely increased. In 1850 it amounted to 800,000 lbs., whereas in recent years it has more than once exceeded 3,000,000 lbs. The produce of Brazil brought to market far exceeds that of all other countries combined. Singapore is the market to which the caoutchouc from Java, Sumatra, Malacca, Borneo, Penang, Manilla, &c., is brought, and from which it is shipped to England. Much of the caoutchouc brought into the market is found to be adulterated with chalk, Paris white, pumice, clay, barytes, oxide of zinc, white lead, red lead, ivory black, lamp black, black lead, and other substances.

CAPACITY, the same in sense as CONTENT of volume in pure mathematics. In physics it generally signifies power of holding or retaining. Thus we speak of the capacity of a body for heat, &c.

CAPELLA, or *α* Aurigæ, a star of the first magnitude, in the body of the goat which Auriga is represented as carrying. [AURIGA.] This is a double star, with a small proper motion, + 0″·13 in right ascension, — 0″·35 in declination.

CAPERS, considered botanically, are the flower-buds of the *Capparis spinosa*, a plant which grows largely upon rocks and ruined walls in the south of France and Italy, and which looks very attractive with its white blossoms and lilac stems. The flower-buds are picked as an article of commerce, to undergo a certain preparation before using. On an average, each plant yields about a pound of buds. The smallest quantity is yielded when picked young; but these are the finest, and bring the highest price. When the buds are picked, they are thrown into a cask of strong vinegar, and sold to dealers, who, by the use of various kinds of sieves, separate the buds into *nonpareils*, *capuchins*, *capotes*, *seconds*, and *thirds*, differing in quality and in price. The green colour of capers is an evil rather than a good; it does not naturally belong to them in the pickled state, but is produced by an artificial application of copper, which is in its nature deleterious. Capers, though not largely consumed in England, find a considerable sale in the south of Europe.

CA'PIAS. This term denotes in law certain writs so called from the occurrence of the word (capias) in the ancient Latin forms:—

1. *Capias ad respondendum.* This is a judicial writ by which all *personal* actions (that is, such as do not relate to land or real property) were, prior to the 1 & 2 Vict. c. 110, commenced in the superior courts of common law against any person whom it was intended to arrest or hold to bail, and who was not already in custody.

Since the passing of that Act, the writ of *capias ad respondendum* is no longer the commencement of the action; and its use is restricted to certain special cases specified in the 3rd section, and noticed above. [BAIL.] In form it is a command from the king to the sheriff, to take the defendant if he shall be found in his bailiwick, and him safely keep until he shall have given bail, or made a deposit according to law in a specified action at the suit of the plaintiff, or until the defendant shall by other lawful means be discharged from custody. The sheriff is also required to deliver a copy of the writ on execution to the defendant; and the defendant is enjoined to take notice that within eight days after the execution of it he must cause special bail to be put in for him in the court from which the writ is issued. The sheriff is also commanded to make his return to the writ immediately after he has executed it, stating the day of such execution; or if not executed within one calendar month from the date, then that he also return it, or sooner, if lawfully required to do so. It is witnessed in the name of the chief judge of the court from which it issues, and is dated on the day it issues.

2. *Capias ad satisfaciendum*, usually called a *ca sa*. This is a writ of execution to imprison the person of the defendant after judgment has been obtained against him, until he make satisfaction to his creditor. It commands the sheriff (of any county within which the defendant is supposed to be) to take the defendant, and him safely keep, so that he may have his body in court on the return of the writ to *satisfy* the plaintiff. This writ must strictly pursue the judgment upon which it is founded; that is, in a judgment against two persons, the *ca sa* cannot issue against one only, without showing upon the face of it a valid reason for it being so; nor can it be sued out for a larger sum than has been *recovered* against the defendant.

Formerly it was the practice to *teste* (that is, date it) in Term time, but now it may be *tested* on the day on which it is issued (3 & 4 Will. IV. c. 67, s. 2). It may also by that act be made returnable immediately after the execution, instead of waiting until the ensuing Term, which was often productive of great loss and delay; nor is it now necessary that any certain number of days should elapse between the *teste* and the return. Where the sheriff can do so, he ought regularly to return, by indorsement on the back of the writ, the manner in which he has executed it; for instance, that he has either taken the defendant and has his body ready, or that the defendant is so ill that he cannot be moved, or that he is not to be found in his bailiwick. The writ, when returned, is lodged with a master of the court out of which it issued;

and a sheriff is answerable in damages to the plaintiff for making a false return.

Every writ of *ca sa* should be indorsed with the party's addition and residence, or such other description as the plaintiff may be enabled to give, together with the amount of the debt which the sheriff is to levy; the plaintiff at his peril indorses more.

The mode of executing this writ is generally the same as in the case of a writ of *capias ad respondendum*. Persons privileged from arrest under the one are generally so under the other. These privileges are noted above. [BAIL.]

The effect of taking a party in execution upon a *ca sa* is, that it operates at once as a satisfaction of the debt, and no other writ of execution can be sued out upon the same judgment against the defendant's goods or lands, unless he die in confinement or escape from custody.

3. *Capias ad satisfaciendum to fix the bail.* Where bail have been given in the original action, they stipulate in this triple alternative, that the defendant shall, if condemned in the suit, satisfy the plaintiff his debt and costs; or that he shall surrender himself a prisoner, or that they will surrender him, or pay the debt and costs for him. [BAIL.] Where therefore the defendant is at large after the judgment, and the bail are responsible, it is often of importance to fix them with the debt; for this purpose a *ca sa* must first be sued out against the principal, upon which the sheriff must return that he is not to be found, for the bail are not bound to render their principal until they know by the plaintiff's suing out this writ, that he means to proceed against the person of the defendant and not against his goods [EXECUTION]; and for the purpose of affording the bail this information, the writ must lie in the sheriff's office four clear days before the return, and be entered in a book kept for that purpose. It must be directed to the sheriff of the county where the action was tried. The sheriff returns that the defendant is not to be found as a matter of course, without even attempting to take him (except where he is actually in his custody) as the *ca sa* is merely intended as a notice to the bail of the plaintiff's intention to proceed against them; and if they do not render their principal in time, the plaintiff may proceed for the debt against the bail.

4. *Capias utlagatum* is a writ that lies against a person who has been outlawed in any action. It is either general or special; the former against the person only, the latter against the person, lands, and goods. (Stat. 2 Will. IV., c. 39, s. 5; and 7 Will. IV. and 1 Vict. c. 45, s. 2.) [OUTLAWRY.]

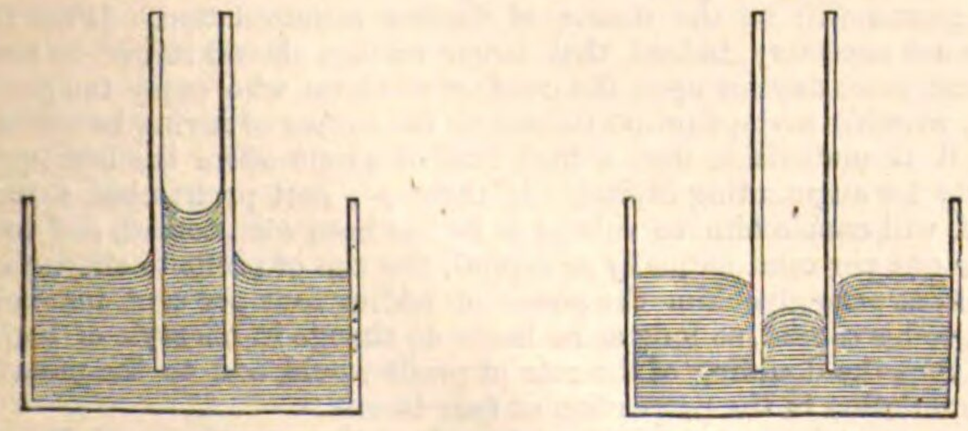
5. *Capias pro fine*, the name of an ancient writ now obsolete, by which the defendant who had judgment given against him might in some cases be arrested for his wilful delay of justice until he paid a fine to the king for the same.

6. *Capias in withernam* was a writ, now obsolete, which lay where a distress taken was driven out of the county, so that the sheriff of that county could not deliver them to the party applying to have them replevied. [DISTRESS, REPLEVIN.]

(*Archbold's Practice*, by Prentice, 10th edit.; *Index, tit. Capias.*)

CAPILLARY ATTRACTION and REPULSION. These names have been given to the properties of matter which cause the ascent or descent above or below the level of the surrounding liquid, which takes place when a tube of very small diameter (like a hair, *capillus*) is dipped into water, mercury, &c. This phenomenon, which excited early notice from its peculiarity and apparent exception to all the laws which regulate the equilibrium of fluids, has given its name to what is rapidly becoming an extensive and well connected theory of the action of the parts of solids and liquids upon each other. We shall, however, in this article confine ourselves to the description of phenomena which are strictly capillary, in the original sense of the word, referring to MOLECULAR ATTRACTION for an account of the general theory which explains these phenomena as particular cases of a more extensive class.

That solid substances, either directly or by means of some interposed agent, attract each other [ATTRACTION, where this article is referred to as CAPILLARITY], or endeavour to produce motion towards each other, has been abundantly demonstrated both by celestial and by terrestrial phenomena. That the parts of solids exercise force on each other is evident from the force which is required to separate them. That the parts of liquids exercise a feeble action of the same kind is also sufficiently obvious. And the common property of most



liquids with respect to solids, namely, that the former *wet* the latter, is proof of a similar connection between solids and liquids. If glass be

dipped into water and then drawn out, a portion of the liquid is drawn out with it, some of which hangs from the bottom of the glass. Here is sufficient proof of a force which overcomes the weight of the liquid; whatever may be its cause or mode of action, there is an attraction of the particles of the water to those of the glass; but the every day character of the phenomenon did not excite much attention until the appearance of the same kind of effect in a peculiar form, namely, that of capillary attraction, made the experiment a *philosophical* one.

The preceding figures represent the appearance (in section) of a liquid into which a tube of very small diameter, but enlarged for the sake of distinctness, is plunged. The liquid either rises or sinks in the tube above or below the level of the exterior; and at the same time is slightly curved at what would be, were it not for this curvature, the exterior *level* immediately adjoining the tube. It is also to be observed that in cases where the liquid stands higher within the tube than without, its upper surface is always concave; but that when the liquid is lower within the tube, it is convex: both appearances are represented in the diagrams. When the solid is one which can be wetted by the liquid, the elevation and concavity are observed; but when the solid appears to repel the liquid, the depression and convexity are observed. Glass and water furnish an instance of the first; glass and mercury of the second. Thus the bulbous appearance of the top of the mercury in a barometer is a phenomenon of the kind represented in the second diagram. [BAROMETER.] The different appearances presented by water and mercury with respect to glass may be thus stated. A drop of water upon a level piece of glass becomes hemispherical or nearly so, and adheres: a very small drop of mercury retains its spherical form, and rolls easily. It is not true that the glass actually repels the mercury; M. Gay-Lussac found that a disc of glass of 120 millimètres, or 4·6 inches, in diameter, required a separating force of from 150 to 300 grammes (a pound avoirdupois is 453½ grammes) to detach it from the surface of a bath of mercury. The inference is that the attraction of the particles of mercury upon mercury is stronger than that of the particles of glass upon mercury, but that the action of glass upon water is stronger than that of water upon water.

The *laws* according to which the liquid rises or falls have been experimentally determined, and are also found to be deductions from the theory which has been proposed for their explanation. They are as follows: 1. The action of the liquid or solid, of what kind soever it may be, is sensible for a very small extent only; thus a tube of dry glass, and the same tube previously wetted throughout its whole interior with the liquid to be examined, cause different amounts of elevation. In the first case, when the equilibrium is established, the particles in immediate connection with the top of the concavity are of glass: in the second case they are of water, and we are in fact immersing a small tube of *water* into water, the glass being merely an outer case, on which the water is deposited. The action of the glass appears not to extend the depth of the thin film of water which comes into immediate contact with the water from the vessel. And it is found that whatever the substance may be which serves as a case for the film, the elevation is the same. 2. When cylindrical tubes of different diameters are compared, the elevation is inversely proportional to the diameter: so that in a glass tube of $\frac{1}{100}$ of an inch in diameter water stands twice as high as in one of $\frac{1}{50}$ of an inch; and so on. The height, however, bears no evident ratio to the density or specific gravity of the liquid used, as Muschenbröck and Gay-Lussac have shown by numerous experiments. 3. Whatever the form of the tube may be, the elevation or depression is found to depend only upon the diameter at the upper part of the elevation: thus, if a small conical tube widening downwards be dipped into a liquid, which is found to rise in it to an elevation at which the tube has a diameter of $\frac{1}{100}$ of an inch, then if a cylindrical tube of $\frac{1}{100}$ of an inch were immersed in the same liquid, the water would rise to the same height as in the conical tube. The converse of this is true, with regard to the *pressure* of a liquid on the base of a vessel containing it. [HYDROSTATICS.] Hence, if a drop of water be placed in the *wide* end of a conical tube, it will rapidly move towards the smaller end. The drop, when placed in the tube, becomes doubly concave, the surface nearest the apex of the tube being the more curved of the two; so that the drop moves towards the apex by reason of the attraction of the sides of the tube for the liquid. Laplace has shown that this attraction is *inversely* as the radius of the curve terminating the liquid column. 4. If the tube be double (one tube within another) the liquid rises to the same height in the interval between the two tubes, as it would do in a tube with that interval for its *radius*. 5. Between two parallel plates immersed at a very small interval the liquid rises as high as in a tube with that interval for its *radius*, that is, only *one half* as high as in a tube having that interval for its *diameter*. 6. Between two plates vertically placed, but inclined at a very small angle (like a double screen nearly closed) the liquid rises higher and higher as we proceed towards the upright line of junction: and the curve of the upper surface of the liquid is an hyperbola. In fact, if we assume the law mentioned in (2) to be correct, and if we take two sides of the plate, vertical and horizontal as co-ordinates, we have at once the equation:—

$$y = \frac{k^2}{x}$$

y being the height of any part of the curve, or its ordinate, and x its

abscissa, which varies as the interval of the plate *directly ;* and k^2 being a constant ; hence

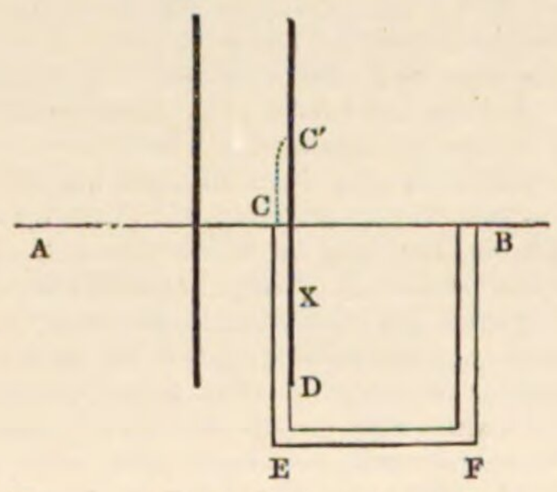
$$xy = k^2$$

which is the equation to a rectangular hyperbola referred to its asymptotes.

We shall not give a table of the results obtained by different experiments, because they vary considerably as to amount, though, in the results of the same observer, the fact, marked (2) in the preceding list, generally appears to be very near the truth. The discrepancy probably arises from the various degrees of internal moisture in the tubes. Experiments have been made from the time of Newton, but it is only since the application of the molecular theory by Laplace that it seems to have been always admitted and acted upon, that the internal coating of the tube immediately adjacent to the liquid is the cause of the phenomenon. The results of various observers upon glass and water give elevations of from two to five inches in a tube of one-hundredth of an inch ; the result of M. Gay-Lussac (who always observed with moistened tubes, and found all his experiments to agree very nearly with each other) gives an elevation of 4·62 inches for the same diameter. The elevations of liquids vary also with the temperature, the former diminishing as the latter increases. It is, however, remarkable that capillary attraction is able to oppose very strongly the evaporation of the liquids. Fine tubes of glass containing water have been exposed for many months in the sun without losing any appreciable quantity of liquid.

A class of phenomena referable to capillary action is the apparent attraction and repulsion of small bodies floating on water, placed near one another. If one of the bodies only, be composed of a substance capable of being *wetted*, mutual *repulsion* will occur ; but if both are incapable of being moistened, mutual *attraction* ensues. When the bodies are *wetted*, the liquid rises around them according to the law of capillarity, but when they are incapable of being *wetted*, the liquid is repelled, and they lie in a *trough*, or hollow depression, and accordingly run together by reason of the lateral pressure of the water beyond, seeming to attract one another.

The phenomena of capillarity discovered by Dutrochet in 1828, will be noticed under the head Osmose. We shall conclude this article with considerations which may give readers who cannot study the mathematical theory, a notion of the manner in which the phenomena may be supposed to arise, referring to Molecular Attraction for some account of the different modifications which the theory has undergone.



The tube being immersed in the liquid, of which the natural level is A B, let us consider a small canal of liquid C D E F B. The glass immediately above C exercises an uncompensated attraction on the liquid ; but at any point X between C and D, the action of the glass is equal upwards and downwards, so that there is no further disturbance till we come to D, where the side of the canal ceases to be of glass, and becomes of liquid. There is then at D the difference of the actions of the glass and liquid, *downwards*, if the action of liquid on liquid be the stronger ; *upwards*, if that of glass on liquid be the stronger. We suppose the actions to extend to very small distances only. But the counterpoising column B F is in its natural state. If then twice the action of the glass on the liquid (namely, those exerted at C and D) exceeds that of the liquid on the liquid at D, a part of the weight of the column C D is counterbalanced by the excess of upward pressure, and this column, so relieved, cannot counterbalance the weight of B F, unless its length is so increased that the excess of length may counterpoise the upward pressure. The liquid immediately adjoining the side will therefore rise, and the same all round the interior of the tube. But so long as the cohesive quality of the liquid exists, the liquid still more in the interior of the tube will also rise, and this will continue until the whole body of liquid raised is a counterpoise to the inequality of the actions. Similarly, if the action of the liquid at D exceed those of the glass at C and D, there will be a downward pressure equivalent to an increase of weight in the column C D. That column therefore will fall, and with it the column still more in the interior. This explanation, though exceedingly imperfect, will serve to give the first notion on the subject : and the following experiment tends to confirm it. If the tube be filled with liquid, and then held vertically with the lower opening stopped by the finger, which is then gently removed, some of the liquid will drop out, but a column will remain suspended in the tube, ended by a hanging drop from the lower extremity. And it is always found that the length of this column is considerably greater than the elevation when the tube is immersed in the liquid : in fact, the action of the liquid below D on the right is now removed, or a pressure downwards is removed, consequently a longer column is required to counterbalance the actions of the glass at C′ and D.

In consequence of the minuteness of the tubes which are required to produce sensible effects, few persons have the means of making experiments on this subject for their own instruction. But a lump of white sugar or a fine sponge, either of which is a collection of minute tubes, held with the lower end slightly immersed, will immediately cause an ascent of the liquid.

CAPITAL is a term used in commerce to express the stock of the merchant, manufacturer, or trader, used in carrying on his business, in the purchase or manufacture of commodities, and in the payment of the wages of labour ; and is understood not only of money, but of buildings, machinery, and all other material objects which facilitate his operations in trade. The term itself, and the practical qualities and uses of capital, are sufficiently understood in this its commercial sense. Capital in a more extended sense, as within the province of political economy, may be defined as the products of industry possessed by the community, and still available for use only, or for further production.

To consider capital in all its relations to the material interests of man, to the increase of population, the employment and wages of labourers, to profits and rent, it would be necessary to travel over the entire range of political economy ; but this article will be confined to the following points :—I. The origin and growth of capital. II. Its application and uses.

I. A desire to accumulate some portion of the produce of industry being natural to mankind, and nearly universal, the growth of capital may be expected wherever the means of accumulation exist ; or, in other words, wherever men are not obliged to consume the whole products of their labour in their own subsistence. From the moment at which a man produces more than he consumes, he is creating a capital ; and the accumulated surplus of production over the consumption of the whole community is the capital of a country.

Thus far the origin and growth of capital are perfectly intelligible ; but in order to understand completely the progress of accumulation, it will be necessary to advert to certain matters which interfere with its apparent simplicity. A distinction has been drawn between those parts of the products of labour which are reserved for the reproduction of other commodities, and those parts which are intended solely for use or consumption. These two classes of products have been divided by Adam Smith and others into capital and revenue ; by which division all products are excluded from the definition of capital unless they be designed for aiding in further production. The impropriety of this distinction, however, has been pointed out by Mr. M'Culloch (' Principles of Political Economy '), and it does not appear that any such division of the stock of a country is founded on a proper distinction. How can its future application be predicated ? The fund exists, and so long as it is not sent abroad or consumed it must be regarded as capital. The whole of it may be made available for further production, or the whole may be consumed in present enjoyment ; but no part is separable from the rest by an arbitrary classification. The stock has the same capacity for production while in the possession of the owner.

But it must be observed that the accumulation of capital proceeds slowly or rapidly in proportion as one or other of these modes of expenditure is most prevalent. If men habitually consumed or wasted all the results of their industry, it is obvious that the effect of such conduct would be precisely the same to themselves, in preventing accumulation, as if they were unable to earn anything more than was absolutely necessary for their support. It is true that they would enjoy more of the luxuries of life, and, as will presently be seen, their expenditure would conduce, indirectly, to the accumulation of capital by others ; but still their labour would only suffice for their own support from year to year, and no part of the produce of last year's labour would be available, in the present year, either for their support or for any other purposes.

As it is evident from these illustrations, that capital must increase in the ratio in which the products of labour exceed the expense of subsistence, it would seem to follow as a necessary consequence that, when a certain amount of capital has already been produced, the higher the rate of profit which may be obtainable from such capital, the greater will be the means of further accumulation. [Profits.] It is not necessary, indeed, that larger savings should in fact be made, as that must depend upon the conduct of those who enjoy the profits. Yet, whether savings proportionate to the means of saving be made or not, it is undeniable that a high rate of profit offers the best opportunity for augmenting capital. If three *per cent.* profit upon a man's stock will enable him to subsist as he has been accustomed, and to lay aside one per cent. annually as capital, the rise of profit to six *per cent.* would at once give him the power of adding four per cent. instead of one, to his capital, so long as he made no change in his style of living : and thus the doubling of the rate of profit would add to the means of accumulation in the proportion of four to one.

But, apart from abstract reasoning, does the experience of different countries bear out the same conclusion ? These questions do not always receive the same answer. Mr. M'Culloch compares the progress

of the United States of North America, in wealth and population, with that of England and Holland, and ascribes the comparative rapidity of their advancement to the fact, that the rate of profit is generally twice as high in America as in either of the other countries. ('Principles of Pol. Ec.') He adds, that if the rates of profit have become comparatively low, the condition of a nation, "how prosperous soever in appearance, is bad and unsound at bottom." Professor Jones, on the other hand, denies this inference, and takes a more encouraging view of the state and prospects of our own country. He says, "That fall of the rate of profits, which is so common a phenomenon as to be almost a constant attendant on increasing population and wealth, is, it will be seen, so far from indicating greater feebleness in any branch of industry, that it is usually accompanied by an increasing productive power in all, and by an ability to accumulate fresh resources more abundantly and more rapidly. So far, therefore, is this circumstance from being, as it has hastily been feared and described to be, an unerring symptom of national decay, that it will be shown to be one of the most constant accompaniments and indications of economical prosperity and vigour." ('Distribution of Wealth,' Preface.)

These opinions, apparently conflicting, upon matters of fact, may prove, upon examination, not to be wholly irreconcilable. It is doubtful whether the United States of North America be a good example for the purpose of this inquiry, as there have been many concurrent circumstances in operation in that country, all tending to the same result; and of which high profits may be regarded as the effect rather than the cause. It will be safer, therefore, to confine the examination of the effects of high profits upon accumulation to our own country at different times.

First, then, it will be admitted on all hands that individual fortunes have been more rapidly accumulated in England at those times in which the profits in particular departments of industry were the highest. This admission is no more, in other words, than the truism, that when a trade is prosperous money is made by it. The next question is, whether a high rate of profit in all departments of industry has the same effect in augmenting the sum total of national capital. Political reasoners are too apt to assume a universal analogy between individuals and nations, which is often deceptive, and leads to inaccurate conclusions. In the present instance, if this analogy were allowed, it would be decisive of the whole question, and would exclude all observation of facts. The fact, as stated by Professor Jones, is undeniable, that a fall in the rate of profits is the ordinary accompaniment of increasing population and wealth. There is more capital in England and in Holland, in proportion to the population, than in any country in the world, and in those countries the rate of profit is the lowest. The resources of England have been increasing in an extraordinary manner during the last half century; and, at the same time, the more evident the wealth of the country has become, the lower has fallen the general rate of profits.

The examination of the causes of profit is reserved for a separate article [PROFITS]; but here it may be stated that a fall in the rate of profits is the inevitable result of enormous accumulations of capital. Capitalists are forced into competition with each other, and are ultimately obliged to content themselves with lower profits. But in the meantime, does the aggregate accumulation of national wealth diminish? This inference is contradicted by all the statistics which illustrate the progress and present condition of Great Britain. All evidence shows that British capital is positively overflowing, and seeking employment in every enterprise at home or abroad.

This fact, it is submitted, is nevertheless consistent with the general proposition, that high profits are favourable to accumulation. In calculating the aggregate savings of a people already rich and populous, it must be borne in mind, first, that the existing generation has inherited the accumulations of many preceding generations; and, secondly, that a large number of persons continually saving a small portion of their individual gains may produce a greater aggregate accumulation than the larger proportionate savings of a less number of persons.

With reference to the first point, it need only be observed, that if the inherited capital be not squandered or wasted, its annual interest alone affords the means of enormous accumulation; while the rent of land, the profits of trade, and the wages of labour, are continually supplying new funds for further production and accumulation. The second point may be made clearer by an illustration. Let us suppose one hundred men, each saving 100*l.* annually out of their profits. Their aggregate accumulations would amount to 10,000*l.* But suppose one thousand men, with equal capitals, but unable, on account of a lower rate of profit, to save more than 50*l.* a year; their aggregate accumulations would amount to 50,000*l.* In both cases they would have maintained themselves and their families out of their profits, and have paid the wages of all the labour required in their business; after which their savings remain available for increased production, and for the employment of a larger quantity of labour. This example falls far short of the circumstances of Great Britain, for the number of small capitalists is even more extraordinary than the enormous capitals possessed by a comparatively small number of wealthy men; and their annual additions to the national capital are of incalculable amount.

The conclusions to which we are led by these inquiries, are—that a high rate of profit is favourable to accumulation; that rich and populous countries are denied this advantage; that if they enjoyed it, their capital would continue to increase more rapidly than it does, in fact, increase; but that under ordinarily favourable circumstances, the masses of inherited capital and the aggregate savings of vast numbers of capitalists still facilitate accumulation in a greater ratio than the increase of population.

II. The consideration of the application and uses of capital will be disembarrassed of much complexity by explaining, at the outset, the distinction raised by political economists between what is called productive and unproductive labour and expenditure. The end of all production is use or consumption: some products are immediately destroyed by the use of them, as food or coals; others are consumed more slowly, but are ultimately destroyed by use, as clothes or furniture: but whatever is the durability of the thing produced, its sole use is the enjoyment of man. A man is rich or poor according to his power of obtaining the various sources of enjoyment which the skill and industry of others produce; and the aggregate of such permanent sources of enjoyment constitutes the wealth of nations. Whatever labour or expenditure, therefore, may be devoted to the increase or continuance of those sources of enjoyment, must be deemed productive: and labour and expenditure, which have no such tendency, must be viewed as unproductive.

The most scientific classification of productive and unproductive descriptions of labour and expenditure which we have met with is that of Mr. Mill. According to his definition the following are always productive:—When their "direct object or effect is the creation of some material product useful or agreeable to mankind," or "to endow human or other animated beings with faculties or qualities useful or agreeable to mankind, and possessing exchangeable value:" or "which, without having for their direct object the creation of any useful material product, or bodily or mental faculty or quality, yet tend indirectly to promote one or other of those ends, and are exerted or incurred solely for that purpose." Labour and expenditure are said to be unproductive when they are "directly or exclusively for the purpose of enjoyment, and not calling into existence anything, whether substance or quality, but such as begins and perishes in the enjoyment;" or when they are exerted or incurred "uselessly or in pure waste, and yielding neither direct enjoyment nor permanent sources of enjoyment." ('Essays on Unsettled Questions of Political Economy,' Essay III.) Examples of these several classes would transgress our limits, but a study of the above definitions may serve to correct an erroneous impression, that no expenditure is productive unless it be incurred directly in aid of further production.

The employment and aid of productive industry is the most important end of capital. Its first and most important use is the division of employments, which, though necessary for any advance in arts, is impracticable without some previous accumulation of capital. Until there is a fund for employing labour, every man's business is the seeking of his own daily food; but as soon as the capital of another secures that for him, his labour is available for the general good. The more capital is accumulated, the more extended are the facilities for indefinite distribution of employments, according to the wants of the community.

Capital may be applied either directly in the employment of labour, or directly in aid of labour: it may be spent in the food and clothes of labourers, or in tools and other auxiliary machinery, to assist their labour and increase its productiveness. The former is usually termed circulating capital, and the latter fixed capital. Both are equally essential to the progress of the arts and national wealth, and are used in combination; but the effects produced by each are not always the same. If a farmer employs three labourers, and his capital is afterwards doubled, it is a very important question whether he expend his increased stock in the payment of three additional labourers, or in providing auxiliary machinery to increase the power of the three labourers, already employed. In the latter case we may be assured that his machinery will do the work of more than three men; for otherwise no ingenuity would have been applied to its contrivance. It is truly said by Professor Jones, that "when, instead of using their capital to support fresh labourers in any art, (a people) prefer expending an equal amount of capital in some shape in which it is assistant to the labour already employed in that art, we may conclude with perfect certainty, that the efficiency of human industry has increased relatively to the amount of capital employed." ('Distribution of Wealth,' p. 222.) The same able writer has pointed out another difference in the results of auxiliary capital, namely, "that when a given quantity of additional capital is applied, in the results of past labour, to assist the labourers actually employed, a less annual return will suffice to make the employment of such capital profitable, and therefore permanently practicable, than if the same quantity of fresh capital were expended in the support of additional labourers." (Ibid. p. 224.) This circumstance arises from the greater durability of the fixed capital, which may not require renewal for several years, while the direct expenditure on labour must be renewed annually. Thus 100*l.* spent in labour to cause a profit of 10 per cent. must produce results amounting in value to 110*l.*: but the same sum expended upon any machinery calculated to last for five years would be equally well repaid by a return of 30*l.* a year; being 10*l.* for profit upon the outlay, and 20*l.* for the annual wear and tear of the capital.

Not only does capital facilitate divisions of employment, and in-

crease the productiveness of industry, by which the enjoyments of man are multiplied, but it actually produces many sources of power and enjoyment, which without it could have no existence. It is the foundation of all social progress and civilisation, for without it man is but a savage. It must precede his mental culture, for until it exists his noble endowments are idle or misemployed. Without it, his mind is a slave to the wants of his body: with it, the strength of others becomes subservient to his will, and while he directs it to increase the physical enjoyments of his race, his intellect ranges beyond the common necessities of man, and aspires to wisdom—to government and laws—to arts and sciences. In all the nations of the world riches have preceded and introduced intellectual superiority. In numberless processes of art capital enables work to be executed which could not otherwise be performed at all, or enables it to be performed better and in less time. In all ways it multiplies indefinitely the varied sources of enjoyment that are offered to civilised man; but never more conspicuously than when it stimulates and encourages invention.

The paramount value of capital to the prosperity of a nation should never be overlooked by a government. Unwise laws, restrictions upon commerce, improvident taxation, which are unfavourable to its growth, should be dreaded as poison to the sources of national wealth and happiness. No class is the better for its decay or retarded growth: all derive benefit from its increase. And above all, when population is rapidly increasing, let a government beware how it interferes with the natural growth of capital, lest the fund for the employment of labour should fail, and the numbers of the people, instead of being an instrument of national power, should become the unhappy cause of its decay. The material happiness of a people is greatest when the national wealth is increasing more rapidly than the population; when the demand for labour is ever in advance of the supply. But while the natural growth of capital should not be interfered with by restrictions, the opposite error of forcing it into particular channels should equally be avoided. Industry requires from government nothing but freedom for its exercise; and capital will then find its own way into the most productive employments. The best means of aiding its spontaneous development are a liberal encouragement of science and the arts, and a judicious system of popular education and industrial training; for as "knowledge is power," so is it at once the best of all riches and the most efficient producer of wealth.

CAPITAL. [COLUMN.]

CAPITE, TENANTS IN. [BARON.]

CAPITOL, CAPITO'LIUM, MONS CAPITOLI'NUS, a hill, a fortress, and a temple, celebrated in the history of ancient Rome. The temple and the fortress no longer exist; and the hill is called by corruption Campidoglio. It rises on the eastern skirts of the inhabited part of modern Rome, which it divides from the Forum and the other forsaken districts of the ancient city. The Capitoline Mount is of an oval shape, and about one mile in circumference at its base; it is divided from the Quirinal to the N.E. by a narrow valley, in which the Forum of Trajan once was, and the pillar still is; it has to the E. the Forum of Augustus and the Via Sacra, which divides it from the Esquiline hill; to the S.E. the valley of the Forum Romanum, which divides it from the Palatine hill; to the S. the Forum Boarium, which divides it from the Aventine hill; and the Tiber to the S.W. It has two summits, one to the N. towards the Quirinal, on which the church and Franciscan convent of Ara Cœli now stand; and another to the S. towards the Tiber, on which are the palace and garden of Caffarelli. At the S. end was the Tarpeian rock, down which state-criminals were hurled. The height of this side of the hill is very much reduced, the ground at the foot of it having been considerably raised by ruins and rubbish, and the rock itself having been sloped down, and houses built against it. Still it rises abruptly in one place, to the elevation of 80 palmi (65 feet), at the back of the Caffarelli gardens, above Piazza Montanara. The height of the Capitol, taken at the pavement of the church of Ara Cœli, which is the highest summit, is 155 feet above the sea, 135 feet above the Tiber taken at its medium height, and about 90 feet above the present surface of the Forum, which however is in several places 20 feet higher than its ancient level.

The hill is said to have been called Saturnius in the ante-Roman times. When the first Romans built their town on the Palatine, they chose the opposite hill, which was then more abrupt, to build their arx or citadel upon. In their first war with the Sabines, according to the old story, the latter took possession of this stronghold by the treachery of a woman called Tarpeia, the daughter of the Roman commander. Hence the hill took the name of Tarpeius. After the peace Tatius and his Sabines settled on the Tarpeian Mount, and Romulus remained on the Palatine. Tarquinius the Elder began to build a temple to Jupiter on the Tarpeian Mount, the summit of which he levelled for the purpose. The building was afterwards continued by Tarquinius Superbus, who engaged workmen from Etruria for the purpose, and employed in it the money resulting from the plunder of Suessa Pometia, a city of the Volsci, which he had taken and destroyed. Wishing the place to be wholly consecrated to Jupiter, he ordered the chapels and votive altars erected by Tatius and others to be removed. The augurs consulted the flight of birds to ascertain the will of the gods, and all were declared to have assented except the god Terminus, who would not stir from his place. This was considered as an omen of the perpetuity of the new edifice and of the city. In digging some part of the foundations, the workmen were said to have found a human head quite fresh, which was interpreted to signify that the spot would be the head and centre of the Roman power. (Livy, i. 55.) The temple was accordingly dedicated to Jupiter Capitolinus, from caput, "a head." It has been a subject of dispute whether this temple stood on the N. or S. summit of the hill; it seems probable, however, that it stood on the N. side, where the church of Ara Cœli now stands. (Nardini, Ficoroni, &c.) It is said to have stood *in arce*, "in the citadel," which was originally on the S. summit; but as the entire mount was afterwards inclosed by walls and fortified, the word arx was used indiscriminately for the whole. The temple is said to have had its front to the S. towards the Aventine; had it been at the S. extremity, there would have been no access to it, except at the back, by the Clivus Capitolinus. This is one of the arguments used by Nardini and others. The temple of Jupiter Capitolinus was burnt in the civil war of Marius, but Sulla rebuilt it with much greater splendour and of the most costly materials. It is said to have been 200 feet long and 185 wide; it had a peristyle with three rows of marble columns in front, and two rows of pillars divided the interior into three aisles, at the furthest end of which were three cellæ dedicated to Jupiter, Juno, and Minerva. The vault of the temple and the external roof were covered with plates of gold. This temple was the principal sanctuary of Rome, to which the victorious generals and emperors went in triumphal procession to sacrifice to the gods. Other temples were raised successively on the Capitoline hill, such as that of Juno Moneta, with the mint annexed to it; of Jupiter Feretrius, said to have been built by Romulus; of Mars, of Venus, of Fortune, and of Isis and Serapis. The temple of Concord stood on the slope towards the Forum. A Bibliotheca or Library, the Tabularium, Athenæum, Curia Kalabra, the Atrium publicum, and other public buildings, were also in the Capitol. In the intermontium or little valley between the two summits, stood the Asylum or place of refuge, between two plantations of oak trees. It is difficult now to form an idea of the appearance of the place and the effect it must have produced. It is evident that the sides of the hill were much more abrupt and stood higher above the plain below than at present. The only access was from the Forum on the S. side by the Clivus Capitolinus and the Clivus juxta Asylum. There were also 100 steps to ascend to the Tarpeian rock, being probably an opening on that side branching out of one of the two Clivi.

The principal buildings of the modern Capitol consist of three palaces, the work of Michel Angelo, forming three sides of a square, in the middle of which stands the equestrian statue of Marcus Aurelius. The open side is to the N.W. towards the modern city. The palace facing it is that of the senator of Rome; to the left of it is the palace de' Conservatori; and to the right that of the Capitoline Museum, one of the finest collection of statues and sculptures in Italy. The three palaces and the square between occupy the intermontium, the two summits being occupied by the church of Ara Cœli and the palace and gardens of Caffarelli. Two ways lead down by the senatorial palace into the Campo Vaccino, or ancient Forum.

CAPITULA'RIUM, literally "a book divided into chapters," was the name given to the laws issued by the French kings of the first and second races, in the great assemblies of the nobles and bishops which formed the states of the kingdom, for the administration of civil and ecclesiastical affairs. These laws, being classed under heads or chapters, were called capitularies. Childebert, Clotarius, and Dagobert, and afterwards Charlemagne, Louis le Débonnaire, Charles the Bald, &c., issued capitularies. Those of Charlemagne are the most celebrated, being more extensive, more enlightened considering the age he lived in, and forming a real code of legislation which remained in force long after. Ansegisus, abbot of Fontenelles, made a collection in books of the capitularies of Charlemagne and his son Louis le Débonnaire in the year 827. Other collections were published subsequently. After Charles the Simple, A.D. 922, no more capitularies were issued, and no laws or statutes are known to exist of the subsequent period till the time of Louis le Gros, A.D. 1100. Louis le Gros began to issue charters to the communes or churches, but no general laws or ordinances appear to have been enacted, except one by Philippe Auguste in 1190, till the time of St. Louis, A.D. 1260, who began to issue regular ordinances. Baluze published a complete collection of all the capitularies issued by the kings of the first and second race, with notes. (*Capitularia Regum Francorum*, 2 vols. folio, Paris, 1677.)

CAPITULATION, a series of articles expressing the conditions under which a fortress is surrendered to an enemy.

The agreement by which an army or a large division of troops surrenders to a superior force, or engages to evacuate the territory which it occupies, when its strength and condition are yet such as to make itself respected by the enemy, is called a Convention. Such was that made at Cintra, or rather at Lisbon, between the generals of the French and English armies on the departure of the former from Portugal in 1808.

When the provisions and ammunition of a garrison are nearly expended, when breaches have been made in the ramparts of the fortress, and no chance remains of being succoured, the governor of the place is justified in entering into an agreement with the besiegers respecting the terms by which he consents to deliver his charge into their hands; and by the rules of war, as well as from the regard due to a gallant

adversary, he is entitled to obtain an honourable capitulation. It may be observed, that if the governor should postpone the proposals to surrender till his provisions are entirely exhausted, the besiegers may refuse to grant terms to the garrison, which must then surrender at discretion.

When the reign of Napoleon was drawing to an end, and he found himself reduced to the necessity of acting on the defensive, the duty of defending the fortresses of France was impressed on the commanders by every motive which the love of glory and the fear of disgrace can inspire. In the Imperial decree concerning them, it is stated that every commander who shall appear to have defended his fortress like a man of honour and a faithful subject, shall, along with the officers and soldiers who may have distinguished themselves in the defence, be presented on a day of general parade, and receive, in presence of the troops, public testimonials of the emperor's satisfaction; that no time shall be lost in exchanging those who may be made prisoners of war; and that every commander who shall be killed on the breach, or die of his wounds, shall be buried with the same ceremonies as a Grand Cross of the Legion of Honour. On the other hand it is stated, that every capitulation made without a vigorous resistance continued to the last moment, and without having sustained at least one assault on the rampart of the place, is criminal and dishonourable: the commander who so surrenders is made responsible for all the consequences of his cowardice or treachery; he is threatened with all the severity of the law; and the decree consigns to infamy, and punishes with death, him who yields to the menaces or proposals of the enemy.

If the resolution to surrender should be at length taken, the conditions solicited by the governor should be expressed concisely in a few articles, and should be such only as he can expect to obtain consistently with the circumstances of the case. The governor should, however, firmly insist upon their execution when granted. He is not to separate himself from his garrison, but he must share its fate as well after as during the siege; and he is to stipulate in favour of the sick and wounded for as many advantages as he can possibly gain.

It has happened that the governor of a fortress has been induced to leave his post by an invitation to a personal conference with the general of the besieging army, and that advantage has been taken of his absence to assault the place in the hope of gaining it during the confusion then expected to prevail there. History moreover records instances in which the besieging troops have entered the place and committed disorders even while the commanders have been occupied on the breach in drawing up the articles of the capitulation. To avoid such misfortunes the governor of a fortress should on no account go out for the purpose of treating with the enemy, but he must employ in that duty officers on whose zeal and firmness he can rely.

By the terms of a capitulation the arms and military stores in the place are generally given up to the besiegers; the officers and troops of the garrison retaining only their private property, and being allowed to march out with the honours of war, that is, with drums beating, colours flying, &c. When necessary, a convoy is allowed them for protection till they arrive at the place of their destination.

CAPIVIC ACID ($C_{40}H_{30}O_4$). A resinous acid isomeric with pinic acid, and found in balsam of capivi. [Balsam.]

CAPNOMOR is a colourless, limpid, volatile oil, obtained by Reichenbach, with several other products, from the heavy oil of tar. Its odour resembles that of ginger, and it has a styptic after taste. Its density is 0·9775. It is perfectly neutral, boils at 345° Fahrenheit, and distils unaltered. It burns with a sooty flame. It is very slightly soluble in water, but dissolves in alcohol, ether, essential and fixed oils. It dissolves phosphorus, sulphur, and selenium. It combines with chlorine, emitting hydrochloric acid. It mixes with sulphuric acid, and imparts to it a red colour; nitric acid converts it into oxalic acid, carbazotic acid, and another crystalline substance which has not yet been examined. Acetic acid takes up capnomor, and it dissolves several organic acids; potassium and sodium act but slightly upon it, and the alkalies and alkaline earths decompose it but slowly. It has not been analysed.

CAPONNIÈRE, in fortification, is a passage protected on the right and left by a wall or parapet. The term is generally applied to that by which the communications are made across the main ditch of the fortress to the outworks [Bastion, G. *fig.* 1], or from the covered-way to the gorge of an advanced work. When a passage exposed on one side only is thus protected, it has the name of a demi-caponnière.

The projecting parapet is generally of earth, with its upper surface descending gradually to the bottom of the ditch, in order that the enemy may be completely exposed in advancing up to it, and also that the ditch may be defended by a grazing fire from thence. A passage of this kind is however exposed to the plunging fire of the enemy from the crowning battery H, and from that which should correspond to it on the left hand of the front of the fortification; it may therefore be further protected by a parados or elevation of earth extending along its centre; for by this the defenders behind both parapets would be effectually concealed.

Sometimes the caponnière is a vaulted gallery of brickwork, the sides of which are pierced with loop-holes or narrow openings, for the defence of the ditch by a fire of musketry. In this case a trench is cut on the exterior, and parallel to each side of the work, in order to prevent the enemy from approaching near enough to annoy the defenders within.

Palisade caponnières are formed across the ditches of field-redoubts when those ditches are incapable of being defended from the parapets. If covered with a roof for protection against shells or grenades, that roof should be kept below the level of the natural ground, in order that it may be concealed from the view of the enemy at a distance.

CAPRAL. [Rutic Acid.]

CAPRAMIDE. [Rutic Acid.]

CAPRIC ACID. [Rutic Acid.]

CAPRICORN, TROPIC OF. [Tropics.]

CAPRICORNUS, the tenth constellation in the zodiac, as a constellation, but the part of the moveable ecliptic between 270° and 300° of longitude was also so designated. [Ecliptic.] This constellation never rises in our latitude to a greater altitude than 25°, or thereabouts (we speak of the largest stars, α and β, in the horn). Around it, in the visible portion of the heaven, are Aquarius, Equeleus, Delphinus, Aquila, and Sagittarius. The brightest stars, α and β, are on the meridian at midnight towards the end of July. A line drawn through the bright stars in Lyra and Aquila will, when lengthened, not pass far from the two brightest stars in Capricornus, α and β.

The upper half of Capricornus is that of a goat, and the lower half that of a fish. In some of the Eastern zodiacs it is altogether an alligator or sea monster. According to Hyginus, Jupiter fixed this constellation in the heavens in admiration of the ingenuity of Pan, who, when the gods were obliged to escape from the giants in the form of various animals, made himself half goat and half fish, and lived in a river.

The following are the principal stars:—

Character.	No in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
α^1	5	6972	4
α^2	6	6974	3
β	9	6995	3
ϵ	39	7506	4
γ	40	7525	4

CAPRIFICATION, the process by which the maturation of the fig is accelerated in the Levant. It is imagined that fruits which have been bitten by insects ripen sooner than others, the wound appearing to act as a stimulant to the local action of the parenchyma. This is imitated by the Greeks in the following manner, which is called caprification. When the cultivated fig is preparing for becoming ripe, a quantity of the branches of the caprifig or wild fig-tree are brought into the fig orchards and placed upon the cultivated plants. The wild figs are said to bring with them a great number of small insects called *Cynips Psenes*, or *Diplolepis Ficus Caricæ*, which fly among the cultivated figs and pierce their fruit for the purpose of laying eggs. This they say not only brings about an earlier ripening of the fig crop than would otherwise be obtained, but enables the cultivator to obtain two harvests a year. It is, however, thought that the practice deteriorates the quality of the fruit. Caprification has been artificially imitated by puncturing a fig with an awl, and introducing a little oil into the wound, for the purpose of preventing its healing too soon. (De Candolle, 'Physiol. Vegétale,' p. 580; and Treviranus in the 'Linnæa for 1828,' p. 70, tab. 1, fig. 1 and 2, in which last place the insect is figured.) But experiments do not confirm these popular statements; on the contrary, they show them to be mere fallacies. Professor Gasparini, a learned Sicilian botanist, has shown satisfactorily that the *Diplolepis* "neither hastens the maturity of the fig nor causes it to set, nor yet is necessary for that purpose." (See his 'Memoir on Caprification,' translated in the 'Journal of the Horticultural Society,' iii. 185.)

The kind of caprification above-mentioned must not be confounded with another sort, of very high antiquity, that is practised with the date palm, and which has been mentioned by Herodotus (i. 193). In this latter case the clusters of male flowers from wild date trees are brought and shaken over the clusters of cultivated females, which are thus fertilised and enabled to ripen. It is obvious that the two cases are essentially different, although confounded under one common term. In the fig the *Cynips Psenes*, brought by the wild branches, punctures the cultivated figs, which is said to accelerate their ripening; in the palm the pollen of the wild males is shed upon the stigmas of the cultivated females, and fecundates them.

CAPROATES. [Caproic Acid.]

CAPROIC ACID ($C_{12}H_{12}O_4$). This acid, which was discovered by Chevreul, exists either in the free state or in combination with glycerine, in cow's and goat's butter, and also in considerable quantities in cocoa-nut oil. In the series of fatty acids of the general formula $C_nH_nO_4$ it is the member next higher than valerianic acid. It is now seldom prepared from butter, in which it was first discovered. It may be prepared from cocoa-nut oil by saponifying the oil with potash, and distilling the soap with excess of dilute sulphuric acid. The distillate which contains caproic and caprylic acids is neutralised by baryta, the solution evaporated to dryness, and the mixture of the two salts separated by treatment with alcohol, in which the caprylate of baryta

is insoluble, while caproate readily dissolves. From the baryta salt the acid is separated by means of sulphuric acid.

The most advantageous mode of preparing caproic acid is by the action of potash on cyanide of amyl.

$$\underbrace{C_{10}H_{11}C_2N}_{\text{Cyanide of amyl.}} + \underbrace{KOHO}_{\text{Potash.}} + 2HO = \underbrace{KOC_{12}H_{11}O_3}_{\text{Caproate of potash.}} + \underbrace{NH_3}_{\text{Ammonia.}}$$

Cyanide of amyl is boiled for some time with alcoholic solution of potash, large quantities of ammonia escape, and after some time the residue solidifies to a crystalline mass of caproate of potash. This salt is dissolved in a small quantity of water, and a slight excess of sulphuric acid added, by which the caproic acid is liberated in the form of an oil, which floats on the surface. This is rectified and the distillate between 388° and 392° Fahr. collected separately.

Caproic acid is a colourless oily liquid, with an odour at once suggestive of vinegar and of sweat; its taste is acid and sharp, with a sweetish aftertaste. Its density is 0·930. It boils at 388° Fahr. It is soluble in about 90 parts of water, and dissolves in all proportions in alcohol and ether.

Wurtz has observed that caproic acid prepared from cocoa-nut oil, and that prepared from cyanide of amyl, though identical in other respects, differ in this—that while the former is optically inactive, the latter has the property of rotating the plane of polarisation. As all derivatives of amylic alcohol which contain the radical amyl ($C_{10}H_{11}$) have been observed to possess this rotatory power, Wurtz concludes, as Kolbe and Frankland had previously done on other grounds, that caproic acid also contains this radical, and is formic acid in which hydrogen is replaced by the radical amyl.

$$\underbrace{\left.\begin{matrix}C_2HO_2\\H\end{matrix}\right\}O_2}_{\text{Formic acid.}} \qquad \underbrace{\left.\begin{matrix}C_2(C_{10}H_{11})O_2\\H\end{matrix}\right\}O_2}_{\text{Caproic acid.}}$$

The caproates are monobasic, and have the general formula $C_{12}H_{11}MO_4 = MO\,C_{12}H_{11}O_3$.

Caproate of potash ($KO, C_{12}H_{11}O_3$) forms a transparent jelly which becomes opaque by heat. When a solution of this salt is electrolysed, hydrogen and carbonic acid gases are given off, and an oil is formed which is the radical *amyl* ($C_{10}H_{11}$), containing an admixture of caproic acid.

Caproate of baryta ($BaO, C_{12}H_{11}O_3$) crystallises according to the temperature at which it is evaporated, either in large needles or in brilliant hexagonal plates. It fuses at a gentle temperature, and by dry distillation yields gaseous hydrocarbons and a small quantity of a colourless oil, which is a mixture of *caproic aldehyde* ($C_{12}H_{12}O_2$), and of *caprone*, $C_{22}H_{22}O_2 = \left.\begin{matrix}C_{12}H_{11}O_2\\C_{10}H_{11}\end{matrix}\right\}$, the ketone of the series.

Caproate of ethyl, or *caproic ether* ($C_{16}H_{16}O_4 = C_4H_5O, C_{12}H_{11}O_3$), is obtained by distilling a mixture of caproate of baryta, alcohol, and sulphuric acid. It is a limpid oil, boiling at 324° F., and possessing a pleasant odour of pine-apples.

Anhydrous caproic acid ($C_{12}H_{11}O_3)_2$ is prepared by the action of oxychloride of phosphorus on caproate of baryta. It is an oil lighter than water, and perfectly neutral.

CAPROIC ALCOHOL, or *Hydrated Oxyde of Hexyl*, $C_{12}H_{14}O_2 = C_{12}H_{13}O, HO$. This alcohol is contained in very small quantities in the less volatile parts of the brandies prepared from the expressed residue of the grape, along with its homologous propylic, butylic, and amylic alcohols. It is separated by fractional distillation. It is a colourless aromatic highly refracting liquid, insoluble in water. Its density is 0·832, and it boils at about 302° Fahr. As far as it has been examined, it exhibits all the re-actions of an alcohol. By the action of potash it is converted, with disengagement of hydrogen, into caproate of potass, and with sulphuric acid it forms a copulated acid homologous with sulphovinic acid.

Hexyl, $C_{12}H_{13}$. The radical of caproic alcohol, so called from being the sixth in the series of homologous radicals, was obtained by Brazier and Gossleth by the eloctrolysis of œnanthylic acid, in the same manner in which the radical methyl is obtained by the electrolysis of acetate of potash.

$$\underbrace{KOC_{14}H_{13}O_3}_{\text{Œnanthylate of Potash.}} + HO = \underbrace{KO, 2CO_2}_{\text{Bicarbonate of Potash.}} + \underbrace{H + C_{12}H_{13}}_{\text{Hexyl.}}$$

During the operation the hexyl separates as an oily layer on the surface of the solution. It contains other substances admixed, resulting from secondary action, and is freed from them by distillation with potash and subsequent rectification. It is a fragrant oil, boiling at 397° Fahr. It is a very permanent body. It is not attacked by sulphuric acid or by moderately strong nitric acid, but by a mixture of the two it is partially oxidised and changed into a fatty acid, which is probably caproic acid. This radical, or its isomer $C_{24}H_{25}H$, has also been found by G. Williams, as a component of certain oils formed by the destructive distillation of boghead cannel coal.

CAPROIC ALDEHYDE. [Caproic Acid.]

CAPROIC ETHER. [Caproic Acid.]

CAPROILENE. [Hexylene.]

CAPRONE. [Caproic Acid.]

CAPRONITRYLE, or *Cyanide of Amyl*, ($C_{10}H_{11}, C_2N$), is obtained by heating a mixture of caproate of ammonia and anhydrous phosphoric acid, or by distilling together sulphamylate of potash and cyanide of potassium. By boiling with alcoholic solution of potash it is converted into caproic acid. [Caproic Acid.]

CAPROTYL. [Caproic Alcohol: *Hexyl.*]

CAPRÖYL ($C_{12}H_{11}O_2$), the hypothetical negative radical of caproic acid, which is generally regarded as the hydrated oxide of capröyl, $\left.\begin{matrix}C_{12}H_{11}O_2\\H\end{matrix}\right\}O_2$.

CAPRYLAMINE. [Caprylic Alcohol.]

CAPRYLENE. [Caprylic Alcohol.]

CAPRYLIC ACID ($HO, C_{16}H_{15}O_3$) occurs in cow's and goat's butter, in cocoa-nut oil, and in other fatty matters along with acids homologous with it; and is also frequently formed by the oxidation of fatty substances. Its best source is cocoa-nut oil. It is prepared by decomposing the caprylate of baryta [Caproic Acid] by sulphuric acid.

At ordinary temperatures it is an oily liquid, of a sudoriferous odour. At 50° Fahr. it crystallises in needles. It boils at 457° Fahr. It is a monobasic acid, the general formula of its salts being $MO, C_{16}H_{15}O_3$. They have been but little examined.

Caprylic ether or *caprylate of ethyl* ($C_4H_5O, C_{16}H_{15}O_3$) is a colourless liquid, with an odour like that of pine-apples.

CAPRYLIC ALCOHOL, or *hydrated oxide of capryl* ($C_{16}H_{18}O_2$) This alcohol is also called *octylic alcohol* (οκτω, eight), as being eighth in the series of homologous alcohols. It is formed by distilling ricinoleic acid with excess of potash, or more simply by distilling castor oil itself, which consists of ricinoleic acid in combination with glycerine, with excess of caustic potash. The action is tolerably brisk, hydrogen is given off, and an oily liquid passes over, consisting mainly of *caprylic alcohol*, while sebacic acid is formed, and remains in combination with the potash.

$$\underbrace{C_{36}H_{34}O_6}_{\text{Ricinoleic acid.}} + 2KOHO = \underbrace{2KO, C_{20}H_{16}O_6}_{\text{Sebacate of potass.}} + \underbrace{C_{16}H_{18}O_2}_{\text{Caprylic alcohol.}} + 2H$$

Besides caprylic alcohol, the oily liquid contains a ketone *methyloenanthol* $C_{16}H_{16}O_2 = \left.\begin{matrix}C_{16}H_{15}O_2\\C_2H_3\end{matrix}\right\}$ This is removed by agitating the liquid with bisulphite of potash, with which it forms a crystallised compound.

Caprylic alcohol when pure is a colourless oleaginous liquid of an agreeable aromatic odour, insoluble in water, but soluble in alcohol and ether. It boils at 362° Fahr. Exposed to the air, it gradually acidifies—this change is greatly accelerated by platinum black. It forms, with chloride of calcium, a crystalline, easily decomposible compound. By the action of chloride of zinc, it is decomposed with the formation of hydro-carbons, the most abundant of which is an oily liquid, *caprylene* (*octylene*) $C_{16}H_{16}$.

By the action of caustic alkalies, caprylic alcohol is decomposed with the disengagement of hydrogen, and formation of caprylic acid.

Capryl ($C_{16}H_{17}$), the radical of these compounds is obtained by treating chloride of capryl with sodium.

Chloride of capryl ($C_{16}H_{17}Cl$.), a liquid of an agreeable fruity odour, is formed by treating caprylic alcohol with hydrochloric acid.

Iodide of capryl ($C_{16}H_{17}I$), and *Bromide of capryl* ($C_{16}H_{17}Br$), are formed by treating the alcohol with the iodide or bromide of phosphorus. By the action of ammonia on iodide of capryl *caprylamine* $C_{16}H_{17}N = \left.\begin{matrix}C_{16}H_{17}\\H\\H\end{matrix}\right\}N$ is formed: it is a colourless limpid liquid, with an ammoniacal odour, which slightly resembles mushrooms. It forms readily crytallisable salts.

By the action of iodide of capryl on the metallic compounds of the alcohols, Wills obtained a series of double ethers. Of these, the *methyl-caprylic ether* ($C_2H_3O, C_{16}H_{17}O$), the *ethyl caprylic ether* ($C_4H_5O, C_{16}H_{17}O$) and the *amyl caprylic ether* ($C_{10}H_{11}O, C_{16}H_{17}O$) have been described.

Sulphocaprylic acid ($C_{16}H_{17}O, HO, 2SO_3$) is formed by the action of strong sulphuric acid on caprylic alcohol. It forms crystallised salts, and is homologous in all respects with sulphovinic acid.

CAPRYLIC ETHER. [Caprylic Acid.]

CAPS, PERCUSSION. There have been three modes adopted, in different times, for firing off muskets, fowling-pieces, and other kinds of hand-guns, namely, the *match*, the *flint and steel*, and the *percussion cap*; the last of which depends for its principle on modern chemical discoveries.

It has been stated [Arms] that the first kind of hand-gun, called the hand-cannon, was fired by a match applied to the priming at the touch-hole; and that the first approach towards the use of a gun-lock was by placing a small pan at the right hand of the touch-hole to contain the priming-powder, to prevent it from being blown away. The match was applied by hand; but in the *arquebus*, a later invention, it was brought over the touch-hole by means of a trigger, such as had before

been used for shooting the arrow from a cross-bow. Next came into use the wheel-lock, in the time of Henry VIII.; this was a contrivance by which sparks of fire were elicited from a furrowed steel wheel, by friction against a piece of pyrites, or sulphuret of iron; the trigger acted on a lever and chain which made the wheel revolve, and also brought the piece of pyrites down in contact with it, so that the grating of the two together might produce a spark sufficient to kindle the priming of the gun. The next improvement consisted in the substitution of a flat furrowed piece of steel for the wheel, and a piece of flint for the pyrites. By gradual improvements made from time to time, the complicated arrangement of the flint and steel assumed a considerable degree of perfection, and made the gun-lock a very curious piece of machinery. The manufacture of these locks used to form an important branch of Wolverhampton trade; while the manufacture of the flints, especially during times of war, was largely carried on in various parts of England and the Continent where the best flints were found.

The employment of percussion caps, instead of the above contrivances, arose out of the discovery of certain chemical substances which will explode by percussion or a blow without the aid of heat. Such substances are called detonating or fulminating compounds; and the idea of employing them for firing muskets is said to have originated in the following manner:—About the year 1793, on account of a scarcity of saltpetre in France, the French government caused experiments to be made to determine how far a certain preparation of chlorate of potash would answer as a substitute for gunpowder. The attempt was, from various causes, unsuccessful; but it suggested to the mind of Mr. Fordyce, a gentleman of Scotland, the thought of employing some such agent for igniting the gunpowder of a loaded gun. After several experiments, he took to London, in 1806, a fowling-piece having a lock, in which a small piece of apparatus struck smartly against a morsel of fulminating mercury, exploded it, and caused the ignition of the gunpowder. The principle was established, though the details were still imperfect; and Mr. Fordyce was encouraged by the then Master-General of the Ordnance to make further experiments, which he did. Fordyce proposed, as his reward, to be paid the price of the gunpowder which would be saved by the government in two years; but changes of administration, and difficulties of various kinds, interfered with the hoped-for progress of the method; and it was not till many years afterwards that its use became at all extensive in England, or indeed anywhere.

When however it became known that a slight blow would explode certain powders, and that this explosion would ignite gunpowder, numerous improvements became introduced by degrees. Various salts and chemical compounds, such as some of the chlorates, nitrates, and fulminates, will explode in this way; the most familiar example of which is afforded by the "lucifers" or "congreves" now sold so cheaply in the streets, and which ignite so readily by friction (in effect a series of minute percussions). About thirty years ago Dr. Ure conducted a series of experiments for the Board of Ordnance on certain points connected with these detonating compounds; such as the best proportion in the ingredients for fulminating mercury and other varieties; the best mode of preparation; the mode in which gases produced by the explosion affect the iron- and brass-work of a gun; the degree to which moisture or damp injures the mixtures; the effect of difference of climate on them; the best mode of protecting them from injury; and the probable effect of the gases (resulting from the explosion) on the health of a close mass of men in an army. Dr. Ure gives the results of the experiments in his 'Dictionary,' in the course of which he states that the French prepare forty thousand percussion charges from two pounds and a half of fulminating mercury.

When the method was first introduced, there was some difficulty in causing the explosion of the mixture to ignite the gunpowder. But this is now effected by putting the detonating mixture into a little copper box or cell called a *cap*, which is adjusted over the touch-hole, and so arranged as to the other part of the lock, that a smart blow striking the cap explodes its contents: the little cell itself is destroyed, so that a new one is required for each firing. The size of the cell, or "percussion-cap," the nature of the mixture, the quantity employed with each charge, and the mechanism for firing it, have been the subjects of many improvements, some of which were patented. The caps are made in large numbers at Birmingham, in much the same manner as metal buttons; blanks being cut out of sheet copper or mixed metal, and stamped or pressed into the proper shape.

Many contrivances have also been suggested for applying these caps under a modified form to larger guns. Thus, Commander Henderson, in 1838, contrived a means whereby a ship's armourer could adapt percussion caps to the common guns of a ship. The cap is applied to the touchhole, covered with an iron cap, and exploded with a slight blow from a mallet.

The detonating compound, with or without the small containing copper cap, has been applied to several varieties of shells to be fired from mortars, and to explode only when the shell strikes against the object against which it is directed. In ordinary circumstances a bomb-shell, or similar missile, has a fuse so attached to it as to ignite the gunpowder within after a certain space of time; but the object of the detonating shells is to dispense with such a fuse. Colonel Maceroni, in 1826, proposed the use of shells in which a short tube was screwed into one side of the shell, and a percussion-cap placed in the tube, just before the shell was to be fired from the mortar: the striking of the shell against any solid object exploded the compound, ignited the gunpowder, and burst the shell.

Many other such shells have been from time to time proposed, of which those by Captain Norton were a good deal noticed in the public prints about sixteen years ago; the experiments at Woolwich, in 1842, with these shells, were made with the view of determining whether the shell would be *certain* to explode in striking the object.

Percussion caps have now for some years been adopted universally in the armies of Europe. For the English army they are manufactured at Woolwich. The following are the various operations:—

1st. Copper is cut into sheets 24 in. long and $3\frac{1}{4}$ in. wide.

2nd. Each slip is smoothed and brought to its proper dimensions by being passed between rollers.

3rd. Crosses $\frac{3}{4}$ in. in diameter are cut out of the slips.

4th. The crosses are put into iron cylinders lined with copper and made red hot. After remaining in this state for some time they are plunged into cold water to anneal them.

5th. After being pickled in dilute sulphuric acid to remove the oxide,

6th. They are dried by being shaken in a bag of dried sawdust.

7th. They are then oiled in a drum.

8th. The crosses are then put under a die, which punches them into the shape of a cap, making the government mark at the same time. These caps differ from the ordinary caps in having a rim like the brim of a hat, in order to be more easily handled.

9th. They are then cleansed from oil in a bag of sawdust.

10th. They are then arranged by shaking into the holes of a brass plate, which contains 1000, for the purpose of charging.

11th. The plate containing 1000 caps is then placed in the charging machine to be loaded with a composition, consisting of fulminating mercury, chlorate of potash, and ground green glass.

12th. The composition is pressed in by a machine having points fitting into the caps.

13th. The composition which has been pressed into the caps receives a coating of varnish from a frame, to which are affixed a number of small nipples corresponding to the caps, which being dipped into the varnish carry the varnish into them.

14th. The varnish in the caps having been hardened in a steam bath,

15th. The varnish is glazed by polishing each separately in a lathe with a projecting nipple which fits into the cap.

16th. The caps being again shaken in a bag with fine sawdust are fit for use.

They are then packed in parcels of 25 each, which accompany the packages of 20 cartridges.

CAPSICINE is an alkaloid found in the capsules of *Capsicum annuum* and other species of *Capsicum*, which are used in the manufacture of cayenne pepper. It has a burning taste, and may be crystallised. It is insoluble in water and ether, soluble in alcohol. It forms crystallisable salts with sulphuric, nitric, and acetic acids. Its composition is unknown.

CA'PSICUM or bird-pepper, a genus of solanaceous plants, of which the botanical account has been given in the NAT. HIST. DIV.

The fruit or pod of several species of capsicum is used in different parts of the world, and under different names, as a stimulating condiment with food, or externally as a rubefacient, or internally as a powerful excitant to the nerves of the part with which it comes in contact. The *C. annuum*, or Spanish pepper, the *C. frutescens*, or Chilies, called also Cayenne pepper, and the *C. baccatum*, or bird-pepper, are chiefly employed. They are natives of the East and West Indies, South America, &c., and are of great utility, along with different articles of food, in rousing the energies of the stomach when impaired by the heat of the climate, and thereby assisting digestion. Even birds have recourse to the seeds, and many parrots and other birds die during their voyage or soon after they reach Europe for want of this natural stimulant. The pods contain two distinct principles: the one capsicin, an alkaloid, which is the acrid principle; the other an ethereal oil, which is the stimulating principle: it resides chiefly in the external layers of the fruit and in the seeds.

The bruised pods, or Cayenne pepper, may be employed in the form of a cataplasm as a powerful rubefacient, which in many cases is preferable to common sinapisms. It is also of great service as a gargle, either alone or in conjunction with cinchona and serpentaria in the sore throat, when threatening to run into a state of mortification, of scarlatina maligna. It may also be given internally with the same adjuncts in the same disease. In fevers, both typhoid and intermittent, it is often a useful accompaniment to Peruvian bark; and in many cases of dropsy from debility, along with iron it is of great benefit. But it is in dyspepsia, dependent upon atony of the stomach, that it is most serviceable. Vinegar which has acquired its virtues (Chili vinegar) is the most suitable acompaniment to all kinds of fish at dinner. One grain of Cayenne pepper, with four grains of blue pill, is one of the most useful of all preventive agents against cholera. Such a pill, taken every night for three or four nights at bed-time, is invaluable.

CAPSTAN. [WINDLASS.]

CAPSULES. This name is given to two kinds of manufactured articles, having very little relation one to another; the one being as a covering for the corks of bottles, the other as a receptacle for medicines.

In 1842, and again in 1849, Messrs. Betts took out patents for the manufacture of metallic capsules, to cover the corked mouths of bottles and jars. Before that time, such articles had usually been made wholly of tinfoil; but the patentees devised a mode of coating lead with tin, which would enable them to prepare the capsules at a cheaper price. They placed a tin-plate on a thicker lead-plate, united them, and rolled them to the required thickness. For some purposes they coated the lead on both sides with tin, producing a brilliant white ribbon, containing nine times as much lead as tin, and capable of resisting acids. The ribbons, whether singly or doubly coated, were cut into discs, and made into capsules. The manufacture entailed a loss at first, but brought in great profit afterwards. One pickle-merchant was accustomed to use these capsules to the value of 250*l.* a month. The prepared metal itself, under the name of Betts's metal, was used for other purposes besides capsules. The extent of the trade in these small articles was illustrated in two or three ways before the law-courts. In 1856, the patentees applied for an extension of the patent of 1842, on the plea that the early years of its exercise had been unsuccessful; but this was refused, on the ground that there was no special merit in the invention, and that a profit of 20,000*l.* had already been made out of it. About the same time, these capsules became the subject of a chancery-suit between the four brothers Betts, which ended in an award of the property in the capsules to one brother, and sums of money to the other three. A patent trial also occupied one of the Courts, to decide whether certain patents taken out in 1804 and 1820 were of such a kind as to invalidate Betts' patent: another example of the high mercantile value often attached to articles comparatively insignificant.

The capsules which belong to medicine, rather than to manufactures, are sweetened envelopes for nauseous or repulsive medicines. They are generally made of gelatine and sugar, sometimes with a little gum. The mode of producing and filling them is curious. The bulbous end of a metal rod is oiled, and dipped into a strong solution of sweetened gelatine; the rod is whirled round a few times, to diffuse the gelatine over the surface of the bulb; the little gelatine globes are removed when sufficiently dry, placed on large-headed pins to harden, and the pins stuck into a piece of cork. When dry, each little globe or capsule is filled with the liquid medicine by means of a small tube, and the orifice is finally closed with melted gelatine. Some of the capsules are made of gut or fine membrane, shaped by being stretched over an oiled bulb of glass. The medicines administered in capsules are such as balsam of copaiba, castor oil, cod-liver oil, &c.

CAPTAIN (from the French *capitaine*, which comes from the Latin *caput*, a head), in the naval service, is an officer having the government of a ship of war; and, in the army, is one who commands a troop of cavalry or a company of infantry.

In military affairs, the title of captain seems to have been originally applied, both in France and England, like that of General at present, to officers who were placed at the head of armies or of their principal divisions, or to the governors of fortified places. Père Daniel relates that it was at one time given to every military man of noble birth; and adds that, in the sense in which it is at present used, it originated when the French kings gave commissions to certain nobles to raise companies of men, in proof of which he quotes an ordonnance of Charles V. This must have been before 1380, in which year that king died. In the English service the denomination of captain, in the same sense, appears to have been introduced about the reign of Henry VII., when it was borne by the officers commanding the yeomen of the guard, and the band of gentlemen pensioners. (Grose's 'Military Antiquities,' vol. i.)

The established price of a captain's commission is, in the Life Guards, 3500*l.*; in the Dragoons, 3225*l.*; in the Foot Guards, with the rank of lieutenant-colonel, 4800*l*; in the infantry of the line, 1800*l.*; and no officer can be promoted to the rank of captain until he has been two years an effective subaltern. The full pay of a captain in the Life and Foot Guards is 15*s.* per day; in the Dragoons, 14*s.* 7*d.*; and in the infantry of the line is 11*s.* 7*d.* per day.

The duty of a captain in the army is one of considerable importance, since that officer is responsible for the efficiency of his company in every qualification by which it is rendered fit for service: he has to attend all parades; to see that the clothing, arms, &c., of the men are in good order, and that their pay and allowances are duly supplied. When the army is encamped, one captain of each regiment is appointed as captain for the day; his duty is to superintend the camp of his regiment, to attend the parading of the regimental guards, to visit the hospital, to cause the roll to be called frequently and at uncertain hours, and to report everything extraordinary to the commanding officer.

A high degree of responsibility rests upon the commander of a ship of war, since to him is committed the care of a numerous crew, with whom he has to encounter the dangers of the ocean and the chances of battle; and as the floating fortress, with its costly artillery and stores, when transferred to the enemy, increases by so much his naval strength, it is evident that nothing but utter inability to prevent him from getting possession can justify the commander in surrendering. In the old French service the captain was prohibited from abandoning his ship under pain of death; and in action he was bound under the same penalty to defend it to the last extremity: he was even to blow up his ship rather than suffer it to fall into the enemy's power.

The pay of a captain in the navy varies with the rate of the ship, from 61*l.* 7*s.* per month for a first-rate, to 26*l.* 17*s.* for a sixth-rate. Commanders of sloops have 23*l.*, and a captain of marines 14*l.* 14*s.* per month.

From the book of general regulations and orders, it appears that lieutenants of her majesty's ships rank with captains of the army. Commanders (by courtesy entitled captains) rank with majors. Captains (formerly designated post-captains) with lieutenant-colonels; but after three years from the dates of their commissions they rank with full colonels.

The rank of post-captain was that at which when the commander of a ship of war had arrived, his subsequent promotion to a *flag* took place only in consequence of seniority, as colonels of the army obtain promotion to the rank of general officers. Such captain was then said to be *posted;* but this title does not now exist.

Several petty officers in a ship bear the title of captains: thus there is a captain of the forecastle, a captain of the hold, captains of the main- and fore-tops, of the mast, and of the after-guard.

CAPUCHINS. [Franciscans.]

CAR, IRISH. [Stage Carriages.]

CARABINE. [Arms.]

CARAMEL ($C_{12}H_9O_9$) is a name given to cane-sugar when it has been exposed to a temperature of 420°. The sugar loses three equivalents of water, and becomes converted into a brown mass. It is used as a colouring matter by cooks and confectioners, and is also employed for colouring spirits.

CARAPINE, an alkaloid found in the *Carapus guianensis*. It forms crystallisable salts with hydrochloric and acetic acids. Its composition is not known.

CARAT, KARAT. The karatium (*κερατιον*?) was originally the twenty-fourth part of the *marc*, or half-pound, among the French, from whom the word came: so that three carats made an ounce. Eisenschmidt cites a coin of Charles VII., of an ounce weight, bearing the legend—

"D'or fin suis, extrait de ducats
Et fus fait pesant trois karats."

The carat was a small weight used for gold and jewels, and (Paucton) varied greatly in different countries. But at last it went out of use, except only in the sense in which it still exists, namely, that a carat means the twenty-fourth part of any weight of gold or gold alloy. If such a weight be all gold, it is said to be twenty-four carats fine; if one-third only be gold, it is said to be eight carats fine.

The karath occurs (Ducange) in an old English charter as a measure of wine; but this is the *carrada* or *carrata* formerly used as a measure of liquids, and supposed to be the quantity which could be carried in a *carrus* or car.

The carat is also used in the weighing of diamonds, and is equal to $3\frac{1}{8}$ grains troy.

CARAVAN, a travelling body of merchants or pilgrims, who join company for safety and convenience. The term, which is of Persian origin (*Kârwân* in Persian having the same signification as Caravan in English), is applied to journeys in the East, more particularly to those made in Arabia, Nubia, Syria, Persia, and Asia Minor; but the practice obtains, though mostly on a smaller scale, in many other countries.

In the East the caravans have a commercial or religious character, and very frequently both; the greatest of them all, or those which proceed annually to the holy city of Mecca, have always trade as well as prayers in view. These caravans are regularly organised by government, and placed under the direction of officers of high rank, who assign to the different travellers their proper place in the long line of march, and see that good order is maintained. Sixty thousand men and twenty thousand camels have sometimes arrived at Mecca with the Hadji or pilgrim caravans. But this amount is insignificant, compared with the numbers that flocked to the holy city in other ages. The Syrian caravan, as it is called, though it first starts from Turkey, is now the most numerous and the best regulated. This caravan sets out from Constantinople, or rather from the Asiatic suburb Scutari, and collects pilgrims and traders all through Anatolia and Syria. On arriving at Damascus, the caravan is under the protection of the Pasha of Damascus, who derives both honour and profit from the charge. At this pleasant city it generally remains three or four weeks, in order to prepare for a journey of thirty days across the desert. Here also the camels are changed, the Anatolian camel not being considered fit for such a journey. When all is ready, the Pasha of Damascus, or one of his chief officers, puts himself at the head of the caravan, which he accompanies to Mecca. The signal for encamping and starting is the firing of a musket. On its route across the desert, where marauding Arabs are always on the look out, a troop of horse rides in front, and another in the rear to bring up the stragglers. The different parties of travellers, who are distinguished by their provinces or towns, keep close together, and each party knows its proper station. The usual arrangement of the hadjis is to contract with a mekowem, a man who speculates in the furnishing of animals and provisions, has his camels, tents, servants, meat, coffee, &c., and who takes upon himself all the trouble and expense for a given sum.

The Egyptian pilgrim caravan, which starts from Cairo, is regulated

in much the same manner; but it is not so large, and its route, by the head of the Red Sea and through a country where fierce Bedouin Arabs are plentiful, and wells of water very scarce, is much more dangerous.

The Persian caravan to Mecca, which used to come by Bagdad through Mesopotamia and Syria, and the Moggrebin (or Moorish) caravan, which, starting from Marocco, used to travel all through Northern Africa, have both become very irregular, though many Persians, Moors, and negroes find their way to Jidda, the port of Mecca, by sea. Considerable troops of Mohammedan Indians also visit Mecca. The great Indian caravan, which started from Muscat and travelled by Nejd to Mecca, has long been given up.

When the caravans arrive at Mecca, bringing with them goods from so many parts of the world, that city presents the appearance of a vast fair. In former times there was a second great pilgrimage and fair at Medina. This is frequently divided into two portions, the 'tayyarah,' or flying caravan, and the 'rakb;' but even in this each person only carries his own saddle-bags.

Besides these large annual caravans, others on a smaller scale are constantly occurring in the East, where merchants and travellers going the same road wait for one another until they can form a caravan, when they generally appoint one of their voluntary association to regulate the order of march. A recent writer, visiting Ararat, says that in the neighbourhood of that mountain he saw the halt of one of those caravans which traverse Armenia in the way to and from Persia; that its encampment occupied several miles in extent, that nearly three thousand horses were scattered over the plain, and that the carriers and travellers amounted to seven or eight hundred. He adds, that the horses were carefully tended, and that the evolutions of the train were performed without noise and with much regularity.

The *caravan-sarais*, or halting-places for the caravans, are generally plain four-sided buildings, with an inner open court, around which are one or two rows of totally unfurnished apartments for the use of travellers, who are expected to bring with them all they need. They, in fact, only afford some protection for the cattle and goods against marauders, and usually furnish a supply of water. They are commonly situated in the wildest and most desolate places, and the institution and support of them is deemed highly meritorious by all devout Mohammedans.

But the caravan trade is not limited to Southern Asia. The great trade between China and Russia is a caravan trade. The road runs from Peking through the great wall to Chalgan, where the goods are taken from horses and put upon camels, which are kept and let out for this purpose by the Kalka-Mongols. From Chalgan the route lies through part of the desert of Kobi to Kiachta, the great border-market for the barter of Chinese and European articles: the journey is from 70 to 90 days. Other similar lines of route exist in Russia and the countries to the east of the Caspian Sea. All the trade with the interior of Africa is also carried on by means of caravans, though they are there especially known as CAFFILAS. They are composed of camels and asses; and Captain R. F. Burton has given an account of them in his 'First Footsteps in East Africa,' 1856; as also of those of Asia, in his 'Pilgrimage to El Medinah and Meccah,' 1856.

Among the knights of Malta, in whose history it is continually used, the word caravan had a very different meaning. It signified a troop or corps of knights appointed by the Order to serve in any garrison, and also the crew or the cruize of any of their galleys against the Turks; for such cruizes were called caravans, and every knight was bound by the laws of his society to make so many *caravans*, or, in other words, so many sea-voyages.

CARAWAY, OIL OF. The essential oil of caraway is obtained by distilling the crushed seeds of the *Carum Carui*. About five per cent. of the oil is obtained. At first the oil is of a pale yellow colour, but it subsequently becomes brownish; it possesses a penetrating aromatic odour and taste, and an acid re-action. Its sp. gr. is ·938, and it boils at 401°. It appears to contain two hydrocarbons, one analogous to CYMEN, and the other to CUMINOL. Distilled with caustic potash it yields *caruen*, or *carvene* ($C_{10}H_8$), and the residue contains an acrid oil, to which the name *caruacrol*, or *carvole* ($C_{40}H_{28}O_3$), has been given.

Oil of caraway is employed as a flavouring agent, and in medicine. A solution of it in spirit is drunk in Germany, under the name of *Kümmelwasser*.

CARAWAYS, the ripe fruit of *Carum Carui*, an umbelliferous, European plant, of annual or biennial duration, with finely-divided aromatic leaves, white small flowers, and a fusiform root, not unlike that of a small parsnip. The seeds, as they are vulgarly called, are the furrowed halves of the ripe fruit, have a peculiar aromatic flavour, and are used as an agreeable carminative by confectioners; the roots themselves are eaten in the north of Europe.

Caraways are used in medicine as a carminative, and more extensively by the confectioners, and by the brewers' druggists to give flavour to the beer. The chief English cultivation of the plant is in Essex and Suffolk, upon old grass land broken up for the purpose. As it is a biennial, it is generally sown with another plant of the same tribe called coriander; and sometimes a crop of teazles is raised on the same land; the three give a very valuable return during two or three years.

Arthur Young, in his 'Agricultural Survey of Essex,' describes this mode of cultivation minutely. Some old pasture land is ploughed up in spring; if the soil is a strong rich clay so much the better. Ten pounds of caraway seed, ten pounds of coriander, and twelve pounds of teazle seed are sown together on the newly turned-up soil, and harrowed in. As the plants appear they are carefully freed from all weeds, by repeatedly hoeing the land. The coriander is fit to be cut in July, and is threshed out on a cloth in the field. The produce is sometimes twenty cwt., worth on an average 16*s*. per cwt. The next year the caraway is reaped about the same time, and produces from 3 to 20 cwt., worth 30*s*. per cwt. In the autumn of the same year the teazles are fit to be cut. The produce of these is very various; sometimes worth 12*l*., at other times only a quarter of that amount. The land, which would have been too rich for corn when first broken up, is now reduced to a moderate state of fertility. From this it is evident that it is only under peculiar circumstances that this profitable cultivation can be adopted.

CARBAMIC ACID ($C_2H_3NO_4$). When dry carbonic acid gas (CO_2) and dry ammoniacal gas (NH_3) are brought into contact, a white solid substance results. This has been called anhydrous carbonate of ammonia, but as it differs from that salt in all its more important characters it is now always classed with the amidated acid compounds produced by the re-action of dry ammoniacal gas on acid anhydrides, and is called *carbamate of ammonia*. It may be viewed as carbamic acid in which an equivalent of hydrogen is replaced by ammonium (NH_4). Thus—

$$\underbrace{\left.\begin{matrix}NH_2(CO)_2O\\HO\end{matrix}\right\}}_{\text{Carbamic acid.}} \qquad \underbrace{\left.\begin{matrix}NH_2(CO)_2O\\NH_4O\end{matrix}\right\}}_{\text{Carbamate of ammonia.}}$$

Carbamic acid, it will be perceived, is derived from one equivalent of dry ammoniacal gas and two equivalents of carbonic acid; an equivalent of hydrogen of the former and an equivalent of oxygen of the latter uniting to form water.

Carbamate of ammonia possesses a strong ammoniacal odour, is very alkaline, and volatilises at 140° Fahr. Its vapour density is equal to 0·9. Anhydrous sulphuric acid converts it into sulphamate of ammonia, with disengagement of carbonic acid. Heated with sulphurous acid it gives an orange sublimate. Hydrochloric acid converts it, with the aid of heat, into carbonic acid and chloride of ammonium. It is very soluble in water, and is then rapidly converted into neutral carbonate of ammonia. When, however, carbonic acid is passed into solution of ammonia, carbonate of ammonia is not formed till after some time, or when the liquid is boiled. It is important to bear this in mind in the estimation of the carbonic acid in a mineral water, by means of an ammoniacal solution of chloride of calcium, as otherwise an error may occur.

Carbamate of methyl $\left(C_4H_5NO_4, \text{ or } \left.\begin{matrix}NH_2(CO)_2\ O\\C_2H_3\ O\end{matrix}\right\}\right)$ (*urethylane*). One of the several methods of producing this substance is to pass chloride of cyanogen into wood spirit containing a little water. When the latter is saturated it has a strong acid re-action, much ammoniacal salt is deposited, which should be removed and the liquid distilled. When the temperature has risen to about 280° Fahr., the receiver should be changed, and all that passes over between that degree and about 360° Fahr. collected and set aside. After a day or two it deposits crystals of carbamate of methyl, which after strong pressure are usually quite pure. In this re-action other matters are produced, but the principal decomposition is expressed in the following equation:—

$$\underbrace{2C_2H_4O_2}_{\text{Methyl-alcohol.}} + \underbrace{C_2N, Cl}_{\text{Chloride of cyanogen.}} = \underbrace{C_4H_5NO_4}_{\text{Carbamate of methyl.}} + \underbrace{C_2H_3, Cl}_{\text{Chloride of methyl.}}$$

Carbamate of methyl crystallises in elongated tabular plates. They are not deliquescent. Melting-point, when perfectly dry, 125-6° Fahr.; boiling-point, 350° Fahr.; vapour density equal to 2·62: very soluble in water and alcohol, less so in ether. Dilute sulphuric acid decomposes it into carbonic acid, methylic alcohol, and sulphate of ammonia; potash does the same, strong sulphuric acid blackens it, sulphurous acid and an inflammable gas being evolved.

Carbamate of ethyl $C_6H_7NO_4$, or $\left.\begin{matrix}NH_2(CO)_2\ O\\C_4H_5\ O\end{matrix}\right\}$ (*urethane*). Ordinary spirit of wine is saturated with chloride of cyanogen, and the mixture heated over a water-bath in a flask with a long neck. Among other re-actions the following takes place:—

$$\underbrace{2C_4H_6O_2}_{\text{Ethyl-alcohol.}} + \underbrace{C_2N, Cl}_{\text{Chloride of cyanogen.}} = \underbrace{C_6H_7NO_4}_{\text{Carbamate of ethyl.}} + \underbrace{C_4H_5, Cl}_{\text{Chloride of ethyl.}}$$

The resulting liquid poured off from an ammoniacal salt that deposits is submitted to distillation; ether, alcohol, and carbonic ether pass over, and finally leaf-like crystals of carbamate of ethyl are obtained.

This substance may also be produced by the re-action of ammonia on the carbonate or chlorocarbonate of ethyl. It is white, fusible at 212° Fahr., and distils when quite dry at about 356° Fahr., but if at all moist, decomposition occurs, and torrents of ammoniacal gas are

evolved. It is soluble in hot or cold water, alcohol, or ether; the solution is quite neutral, and does not precipitate soluble salts of silver. Its vapour-density is equal to 3·14.

Carbamate of butyl ($C_{10}H_{11}NO_4$, or $\left.\begin{matrix}NH_2(CO)_2 & O\\ C_8H_9 & O\end{matrix}\right\}$) *(butyl-urethane)* is produced from butylic alcohol in a somewhat similar manner to the two previously-mentioned substances. Its boiling-point is about 430° Fahr. It crystallises in very beautiful pearly spangles, which are insoluble in water, but soluble in alcohol or ether.

Carbamate of amyl ($C_{12}H_{13}NO_4$, or $\left.\begin{matrix}NH_2(CO)_2 & O\\ C_{10}H_{11} & O\end{matrix}\right\}$) *(amylurethane)* may also be obtained by the same method from amylic alcohol. It crystallises from boiling water in fine silky needles, which melt at 150° Fahr., and distil without alteration at 428° Fahr.

Sulphocarbamic acid ($C_2H_3NS_4$, or $\left.\begin{matrix}NH_2(CS)_2 & S\\ H & S\end{matrix}\right\}$) is a nearly colourless, or slightly reddish-coloured oily body, produced by decomposing sulphocarbamate of ammonia with dilute sulphuric or hydrochloric acid. It is heavier than water, and possesses a peculiar odour somewhat resembling sulphuretted hydrogen. It decomposes carbonates with effervescence. It is not very stable, soon decomposing into cyanic acid, hydrosulphocyanic acid, and other products.

Sulphocarbamate of ammonia ($\left.\begin{matrix}NH_2(CS)_2 & S\\ NH_4 & S\end{matrix}\right\}$) is obtained by digesting together, in a hermetically sealed tube, at a temperature of 60° Fahr., a mixture of one volume of absolute alcohol saturated with ammoniacal gas and a solution of 0·16 of a volume of bisulphide of carbon (CS_2), or sulphocarbonic acid in 0·4 of a volume of alcohol. Other substances are at the same time produced.

The sulphocarbamate of ammonia crystallises in long prisms of a lemon-yellow colour, and has an odour resembling sulphide of ammonium. Heated with caustic potash it is decomposed into sulphocyanide and sulphide of potassium, water and ammonia.

Metallic sulphocarbamates are produced in most cases when a soluble salt of a metal is added to an alkaline sulphocarbamate. Thus:—

Sulphocarbamate of lead . . .	$\left.\begin{matrix}NH_2(CS)_2 & S\\ Pb & S\end{matrix}\right\}$
Sulphocarbamate of zinc . . .	$\left.\begin{matrix}NH_2(CS)_2 & S\\ Zn & S\end{matrix}\right\}$
Subsulphocarbamate of copper . .	$\left.\begin{matrix}NH_2(CS)_2 & S\\ Cu_2 & S\end{matrix}\right\}$

The lead and zinc salts are white, the copper salt yellow. The nickel salt precipitated in a similar manner is yellow-green, the mercuric salt white, the platinum salt yellow-brown. Lime and baryta salts yield no precipitate.

When sulphocarbamate of ammonia is dissolved in five or six parts of water and aqueous solution of chlorine gradually added, the mixture being well shaken on each addition, white crystalline flocks precipitate. These, purified by washing with water, constitute *hydranzothine*, the decomposition by which they are produced and their composition being thus expressed:—

$$2\left.\begin{matrix}NH_2(CS)_2S\\ NH_4S\end{matrix}\right\} + Cl_2 = 2NH_4Cl + \left.\begin{matrix}NH_2(CS)_2S_2\\ NH_2(CS)_2S_2\end{matrix}\right\}$$

This body is the *bisulphide of sulphocarbammonium*, or simply bisulphide of ammonium, in which two equivalents of hydrogen are replaced by two equivalents of (CS). It is almost colourless and without odour when recently prepared; slightly soluble in water, more so in alcohol and ether.

Sulphocarbamate of ethyl, $\left.\begin{matrix}NH_2(CO)_2 & S\\ C_4H_5 & S\end{matrix}\right\}$ *sulphourethane xanthogenamide*, is produced by the re-action of xanthic ether (disulphocarbonate of ethyl) and ammonia. It is only slightly soluble in water, but very much so in alcohol or ether. By spontaneous evaporation it is obtained in beautiful rhomboidal prisms or octohedra, sometimes very large: heated they melt at about 97° Fahr., and at a higher temperature decompose. Xanthogenamide combines with certain metallic salts, producing crystalline compounds. Nitric acid converts it into a substance that crystallises in prisms; it has been called *oxysulphocyanate of ethyl*.

Sulphocarbamate of amyl, ($\left.\begin{matrix}NH_2(CO)_2 & S\\ C_{10}H_{11} & S\end{matrix}\right\}$) *xanthamylamide*, is an oily body, neutral to test paper, insoluble in water, soluble in alcohol or ether.

Methyl-carbamic acid ($\left.\begin{matrix}NH(C_2H_3) & (CO)_2 & O\\ & H & O\end{matrix}\right\}$) and *Ethyl-carbamic acid* ($\left.\begin{matrix}NH(C_4H_5) & (CO)_2 & O\\ & H & O\end{matrix}\right\}$). The two compounds known as *anhydrous carbonate of methylamine* and *anhydrous carbonate of ethylamine* are combinations of the above acids with methylamine and ethylamine respectively.

Ethyl carbamate of ethyl, ($\left.\begin{matrix}NH(C_4H_5) & (CO)_2 & O\\ & C_4H_5 & O\end{matrix}\right\}$) *ethylurethane*, is a slightly oleaginous liquid, obtained by the re-action of cyanate of ethyl on alcohol. Boiling point, 345° Fahr.; specific gravity, 0·986; vapour density, 4·071.

Phenyl-carbamic acid, ($\left.\begin{matrix}NH(C_{12}H_5) & (CO)_2 & O\\ & H & O\end{matrix}\right\}$) *carbanilic acid*, (or anthranilic acid), has been obtained by Fritzsche, by acting on indigo with caustic potash. It crystallises in colourless prisms, brilliant, large, and transparent. It unites with metals, forming crystalline salts.

Phenyl-carbamate of methyl, ($\left.\begin{matrix}NH(C_{12}H_5) & (CO)_2 & O\\ & C_2H_3 & O\end{matrix}\right\}$) *carbanimethylane*, an oily compound, heavier than water; obtained by treating sulphide of ammonium with nitrobenzoate of methyl.

Phenyl-carbamate of ethyl, ($\left.\begin{matrix}NH(C_{12}H_5) & (CO)_2 & O\\ & C_4H_5 & O\end{matrix}\right\}$) is a body very similar to the above methyl-compound. Ammonia converts it into phenyl-urea and alcohol.

CARBAMIDE ($CONH_2$). This substance is produced by the action of chloro-carbonic acid gas on ammonia. Sal-ammoniac is also formed at the same time. Under the influence of the mineral acids, carbamide yields ammonia and carbonic acid, According to the recent experiments of Natanson, carbamide is identical with urea, and the above formula therefore requires to be doubled ($C_2H_4N_2O_2$). [UREA.]

CARBANILIC ACID. [CARBAMIC ACID: *Phenyl-carbamic Acid.*]

CARBANILIDE, or *Diphenylcarbamide* ($C_{26}H_{12}N_2O_2$). This substance is carbamide, in which two equivalents of hydrogen have been replaced by two of the radical phenyl ($C_{12}H_5$). It is prepared by passing chloro-carbonic acid gas into aniline. The re-action is thus expressed:

$$\underbrace{C_2O_2Cl_2}_{\text{Chloro-carbonic acid.}} + 2\underbrace{(C_{12}H_7N)}_{\text{Aniline.}} = 2HCl + \underbrace{C_{26}H_{12}N_2O_2}_{\text{Carbanilide.}}$$

It is a white crystalline inodorous body, capable of being distilled without decomposition. It fuses at 401° F.

CARBAZOTIC ACID ($C_{12}H_3(NO_4)_3O_2$). This acid, which has also been called *picric acid, nitropicric acid, nitrophenisic acid,* and *trinitrophenylic acid*, results from the action of nitric acid upon a great number of vegetable and animal substances. A large quantity is furnished by indigo: one part of this substance reduced to coarse powder is to be gently heated with eight or ten times its weight of moderately strong nitric acid. The indigo dissolves with the evolution of much nitric oxide gas. As soon as the effervescence is over, the liquor is to be boiled, and nitric acid added from time to time till the evolution of nitric oxide ceases: on cooling, crystals of carbazotic acid are obtained, which are of a brilliant yellow colour; they are to be washed with cold water, dissolved in boiling water, and re-crystallised. Carbazotic acid is however now made by acting upon carbolic acid with nitric acid.

The pure acid is said to crystallise in equilateral triangular laminæ, the primary form being an octahedron with a rhombic base. It reddens litmus paper, and has a very bitter taste, and on this account it was long called *bitter of indigo*. When heated, it fuses and sublimes without decomposing. If it be rapidly heated in the air, it burns without explosion, leaving charcoal. This acid is but slightly soluble in cold water, but much more so in hot; the solution is of an intense yellow colour. Alcohol and ether dissolve it readily. Chlorine and iodine do not act upon this acid, even when it is fused in these substances. Heated with aqua regia it gives chloranile and chloropicrin. It contains no water, and is said to be poisonous.

The saline compounds of this acid are called *carbazotates* or *nitropicrates*. An account of them may be seen in Gerhardt's 'Traité de Chimie,' tome iii. p. 41.

Carbazotic acid is now extensively employed for dyeing silk and wool yellow. It is also said to be sometimes fraudulently substituted for hops in the manufacture of beer.

CARBETHYLIC ACID. [ETHYL, *Carbovinic Acid.*]

CARBIDE. [CARBURET.]

CARBOBENZOIC ACID, *Myroxylic Acid.* An acid of problematical existence, obtained from *cinnamein*. It is probably impure benzoic acid.

CARBOHYDROGEN. [HYDROCARBONS.]

CARBOLIC ACID = *Hydrated Oxide of Phenyle, Phenylic Alcohol* ($C_{12}H_5O + HO$) is one of the products of coal tar, and is found amongst those portions which boil between the temperature of 300° and 400°. It is procured by washing this peculiar product with twice its weight of potash ley. On the addition of an acid to this mixture, carbolic acid may be obtained in the form of a heavy oil. When pure it is a heavy transparent oil, refracting light very strongly, neutral to test paper, and having a specific gravity of 1·062 to 1·065. It has the taste and odour of creosote, which it much resembles. They are probably identical, or homologous.

CARBOMETHYLIC ACID. [METHYL.]

CARBON. This element and its combinations act an important part in the mineral constitution of our earth. Following the system of Berzelius, the substances containing it are arranged in three groups, the first consisting of the mineral forms of pure carbon, the second of the carbonates, and the third of those carboniferous masses in which the elements are combined according to the principles of organic chemistry, and which have resulted from vegetable matter.

The first group consists only of three essentially different varieties, namely, two crystallised and one amorphous variety of carbon. The crystallised varieties are known under the names of DIAMOND and

GRAPHITE [NAT. HIST. DIV.], whilst the amorphous kind is met with as mineral charcoal interspersed amongst coal and anthracite.

The second group, the carbonates, presents us with a numerous mineralogical family of the highest interest, both in a scientific and in an economical point of view. For the purpose of studying them with the greatest facility the carbonate of lime may be taken as a type, to which the whole family may be conveniently referred. This substance possesses the peculiarity of dimorphism; that is to say, it occurs in forms belonging to two different systems of crystallisation, namely, the rhombohedral and the prismatic, and is called, when its crystals belong to the former, CALCAREOUS SPAR, and when to the latter ARRAGONITE, under which terms they are described in NAT. HIST. DIV. The chemical composition of these minerals is that of a neutral salt, being one atom of carbonic acid united with one atom of the oxide of calcium, or lime, and therefore the chemical composition of both is denoted by the symbol $CaO\ CO_2$. But the oxide of calcium is isomorphous with the similarly constituted oxides of magnesium, barium, strontium, iron, manganese, zinc, cerium, lead, and copper; and each of these oxides occurs combined with carbonic acid in the proportion of atom to atom, some of them producing crystals isomorphous with calc-spar, and others on the contrary with arragonite. But in addition to the mineral species produced by the combination of any one of these oxides with carbonic acid, an endless variety of isomorphous crystals is formed by the combination of two or more of the above carbonates, which are capable, according to the laws of isomorphism, of uniting in any proportion, as may be seen in the varieties of calc-spar, which are known as brown-spar, bitter-spar, dolomite, where portions of the oxide of calcium are constantly replaced by the oxides of magnesium, iron, and manganese. None of the carbonates of these oxides are found, however, like the carbonate of lime, to be dimorphous, and to occur crystallised both in the rhombohedral and the prismatic system; they may be divided therefore into two isomorphous groups, the one headed by calc-spar, and the other by arragonite; and it is only among the oxides of the same group that it is usual to find the one oxide substituted for the other.

The first group crystallised in the rhombohedral system consists of

Calc-spar	$CaO\ CO_2$
Magnesite or talc-spar	$MgO\ CO_2$
Manganese-spar	$MnO\ CO_2$
Iron-spar	$FeO\ CO_2$
Zinc-spar	$ZnO\ CO_2$
Bitter-spar	$CaO\ CO_2 + MgO\ CO_2$
Brown-spar	$(CaO, MgO, MnO, FeO)\ CO_2$

The second group crystallised in the prismatic system consists of

Arragonite	$CaO\ CO_2$
Strontianite	$SrO\ CO_2$
Witherite	$BaO\ CO_2$
White Lead	$PbO\ CO_2$

But although the minerals of these groups are classified together as being isomorphous, this word cannot be used in its strictest sense, and as denoting an exact identity of the angles of inclination between corresponding planes in the different species, as those when measured at the ordinary temperature are found to differ from each other by small but nevertheless very perceptible magnitudes. The following table of the angles in the terminal edges of the ground-forms of the principal species of the first group, and parallel to the faces of which the cleavage planes of each occur, will best show this difference. According to the most careful measurements the angles are:

For Calc-spar	105° 5′
„ Bitter-spar	106 15
„ Manganese-spar	106 51
„ Iron-spar	107 0
„ Talc-spar	107 25
„ Zinc-spar	107 40

The three angles of calc-spar, bitter-spar, and talc-spar, when the chemical composition of these minerals is considered, present a very interesting and striking relation, the angle of bitter-spar being the arithmetical mean between those of the pure carbonates of lime and magnesia, while its chemical composition may be considered also as the mean of the other two, being composed of an atom of carbonate of lime united with an atom of carbonate of magnesia. That this is a particular instance of a more general law, that the increment of the angle in any compound over that of calc-spar is to the whole difference of the angles of the pure minerals, or 2° 20′, in the proportion of the number of atoms of carbonate of magnesia to the total number of atoms in the compound, appears to be established by the analysis and measurements of the French mineralogist, M. Beudant, who has made several experiments for the purpose of ascertaining this fact. An example will at once render this clear. Suppose on measuring the angle of a compound of carbonate of lime and magnesia we find it to be 105° 40′, which gives an increase over 105° 5′ equal to $\frac{1}{4}$ of 2° 20′; according to the experiments of Beudant we should be justified in concluding that the compound consisted of three atoms of carbonate of lime to one of carbonate of magnesia.

In addition to the carbonates above mentioned, four others are known, namely, the native soda, Gay-Lussite, l'azure or blue copper, and malachite, which, although containing elements isomorphous with the former, are nevertheless differently crystallised, as they are of a different chemical composition, containing water of crystallisation.

The third class, all of which contain more or less evidence of their vegetable origin, are amorphous. They are all distinguished from other mineral bodies by their combustibility, the combustion being usually accompanied by flame. They may be divided into the four principal groups of coals, mineral resins, mineral oils, mineral pitches or bituminous bodies. The principal varieties are distinguished by and are described under the names of peat; coal and its varieties, brown coal, &c.; amber, honeystone, resinasphaltum, naphtha, petroleum, mineral pitch, asphaltum.

CARBON (C), a non-metallic elementary solid body, which is widely diffused throughout nature. The purest, and at the same time the rarest form in which it occurs is that of the diamond [DIAMOND, in NAT. HIST. DIV.]; the more common states in which it is met with are those of graphite [GRAPHITE, in NAT. HIST. DIV.] and mineral charcoal; but in these cases it is not free from admixture.

Another well-known form of carbon, but still impure, is the charcoal obtained from the decomposition of wood by heat.

The diamond differs so entirely in its obvious and physical properties from carbon in its more common states, that nothing less than the most decisive evidence of the identity of their chemical nature could have allowed of their being arranged together: the proof of their similarity is stated in the article CARBONIC ACID. In addition to these forms in which carbon occurs pure or in a free state, it is also met with in combination with other elements, in fact by far the largest amount of carbon is thus met with in combination. In combination with oxygen as carbonic acid, it occurs in the atmosphere, and dissolves in the waters of the ocean, rivers, springs, &c. In the same form, but further combined with lime and magnesia, it exists in enormous quantity in the earth's strata, as limestone, chalk, marble, dolomite, &c.; whilst combined chiefly with hydrogen, oxygen, and nitrogen, it enters largely into the composition of coal, peat, and lignite, as also of all animal and vegetable substances. From its invariable presence in organic substances it has been named the organic element.

Charcoal has already been mentioned as carbon procured from the decomposition of wood by burning. This operation is generally conducted in pits made in the ground; sometimes however it is carried on in iron cylinders. Wood is essentially composed of carbon, oxygen, and hydrogen; by the action of the heat it is decomposed, the oxygen and hydrogen are expelled, and uniting in certain proportions form water, and also with carbon various gaseous and other compounds are formed. Among the latter are acetic acid, sometimes called pyroligneous acid, and a peculiar inflammable fluid, known by the name of pyroxilic spirit, and tar.

The remaining charcoal has the following properties: it is black, lighter than water, and full of pores, occasioned by the expulsion of the bodies volatilised. The heavier the wood from which the charcoal is obtained, the denser it is.

Charcoal, from whatever source procured, is absolutely infusible by any degree of heat however great; neither that of a mirror, the oxy-hydrogen blow-pipe, nor the voltaic discharge, being sufficient to produce fusion. In its common state it is one of the worst conductors of heat known, but its power is increased after being strongly heated. Charcoal is a conductor of electricity, which is so far from being the case with the diamond, that it may without insulation be rendered electrical by friction.

Charcoal is tasteless, inodorous, and insoluble in water. It possesses the property of destroying colouring matter, especially the charcoal procured by burning bones, which is usually called animal charcoal; it is largely used for this purpose in sugar-refining. [BONE BLACK.]

Charcoal, in common with other porous bodies, has the power of condensing gaseous bodies; but to a greater degree than most, or perhaps any other substances: graphite, on account of its compactness, does not possess this quality.

Saussure performed experiments to ascertain these facts by plunging a piece of red-hot charcoal under mercury, and introducing it when cool into the gas. He found that box-wood charcoal absorbed in 24 to 36 hours the annexed quantities of the following gases:—

Hydrogen	1·75 times its volume.
Nitrogen	7·5 „
Oxygen	9·25 „
Carbonic oxide	9·42 „
Olefiant gas	35· „
Carbonic acid	35· „
Nitrous oxide	40· „
Sulphuretted hydrogen	55· „
Sulphurous acid	65· „
Hydrochloric acid	85· „
Ammoniacal gas	90· „

These effects appear to depend entirely upon the mechanical action

of the pores of the charcoal, for the gases are not at all absorbed in the ratio of their affinity for carbon, but generally according to the facility with which they are condensed; and thus it is that charcoal absorbs vapours more readily than gases, and liquids than either.

Dr. Stenhouse has recently shown that these effects of *deodorisation* and *disinfection* are due to the combustion of fœtid and noxious substances which is effected within the pores of the charcoal at the expense of the oxygen which exists there in a highly condensed state. Dr. Stenhouse has successfully taken advantage of this valuable property, to construct respirators of charcoal for the purpose of preventing the access of noxious gaseous matters to the lungs, or conversely, in cases of foul breath to hinder the patient from tainting the atmosphere around him. The same chemist also proposes the employment of charcoal for purifying the atmosphere of hospitals, sick-rooms, &c.

Charcoal is highly combustible; it burns in the air when strongly heated, though not very rapidly; during this combustion carbonic acid is formed by the union of the oxygen of the air with carbon.

It has been mentioned that charcoal is not pure carbon, and when a quantity is burnt there always remains a portion of ashes, containing a considerable quantity of carbonate of potash and some other alkaline and earthy salts, which have been taken up from the soil in which the tree grew that furnished the charcoal.

Charcoal is used not merely for combustion, but also for the important purpose of making gunpowder. It is also applied to other various well-known uses. Carbon unites with all the elementary gases to form highly-curious and interesting bodies. Its inorganic compounds with oxygen are treated of under CARBONIC ACID and CARBONIC OXIDE; with chlorine, CHLORIDES OF CARBON; and with nitrogen, CYANOGEN. It combines also with sulphur to form bisulphuret of carbon, and it enters into the composition of several ternary compounds. Carbon enters into the constitution of all organic bodies, as will be seen from a reference to the formulæ of such bodies, which will be found described under their respective names.

CARBON, in an impure state, or charcoal, is employed medicinally, both internally and externally. Its power of absorbing gases and moisture renders it useful in some cases, while in other cases it seems to act by some power exerted on the vital energies of the system. A few grains of vegetable charcoal taken into the stomach cause a feeling of warmth and comfort in that organ, followed by a slight increase of the heat of the body generally. A considerably larger dose will occasion vomiting, and even diarrhœa. Charcoal, especially animal charcoal, possesses the power of destroying the colour, smell, and taste of a great variety of vegetable and animal substances, particularly of mucilages and oils, and of matters in which *extractive* abounds. Recently prepared charcoal, especially animal, has been recommended as an antidote in poisoning by aconite and other alkaloids. Allowed to remain in contact with valerian, galbanum, balsam of Peru, or musk, it destroys their characteristic odour and properties.

Meat and game, too far decomposed, may be restored to a condition fit for use by the employment of finely powdered charcoal, assisted by sulphuric acid. Water also may be restored from a tainted state by filtering it through charcoal. The interior of water-casks is charred in order to preserve the water in a pure state. Leeches, fish, &c., live better in water kept in charred vessels than in those of any other kind.

Charcoal, both from its antiseptic and vital properties, is useful in many forms of fever, especially the bilious, remittent, and intermittent fevers of warm climates, given during the interval of the vomiting of the black matter; and in yellow and typhoid fevers. It is also serviceable in dyspepsia, accompanied with fetid breath and eructations. It is sometimes of service in ulcerations of the tongue and fauces, connected with depraved digestion. It is likewise useful in obstinate constipation, given in doses of two or three dessert-spoonfuls every half-hour, or each hour, for a period of perhaps eighteen hours. In smaller doses it has been found useful in dysentery, where the motions are acrid and very offensive. Externally it is a beneficial application to foul ulcers, applied either in the form of fine powder, or as a cataplasm; but chloride of soda or lime are better applications. Persons who are troubled with excessive and strong-smelling perspirations of the feet find the inconvenience lessened by sprinkling the inside of their stockings with fine-powdered recently prepared charcoal. Finely powdered charcoal may also be employed as a styptic. Charcoal, especially that procured from the cocoa-nut, forms, along with either prepared chalk, rhatany-root, kino, or catechu, perhaps the best tooth-powder which can be employed when the gums are spongy and the breath fetid. A liniment of charcoal is sometimes useful in herpes, ringworm of the scalp, and other cutaneous diseases.

Animal charcoal, particularly that prepared from the flesh and bones of calves, given in the dose of a few grains, three or four times a day, is said to be very efficacious in removing chronic enlargements of the glands.

Carbonic acid gas, in a state of concentration, acts upon the human system as a powerful sedative poison. Unless largely diluted with atmospheric air, it cannot be breathed, as it stimulates the glottis, or entrance to the windpipe, to contraction, which causes the person exposed to this gas to die of suffocation. But even when so far diluted as to be able to pass the glottis, and enter the lungs, it acts as a poison; and also when brought in contact with the skin (pure atmospheric air being breathed at the same time), or with the mucous membrane of the stomach. A variable quantity of carbonic acid gas exists at all times in the air, as essential to the respiration and the life of plants; but any considerable increase of this quantity is deleterious, and destructive to the life of both animals and vegetables, though plants will flourish in an atmosphere containing nine or ten per cent. of carbonic acid gas, provided they are exposed to the direct solar light, for this quantity is poisonous to them in the shade. (Saussure.) The cause of the absence of vegetation in the celebrated poison valley of Java is the existence of a subterranean source of carbonic acid gas, and not the shade of the upas-tree, as is popularly believed.

Carbonic acid gas is evolved from the combustion of fuel, especially charcoal, and during the process of fermentation; also from the coloured parts of the flowers of plants, both by night and day, and from the green parts of plants during the night; from the calcination of lime; and it is apt to be formed and accumulate in mines, particularly coal-mines, where it is termed *choke-damp*, and in old draw-wells, and in the famous *Grotto del Can*. It also is formed or extricated by the respiration of animals, and becomes the source of disease and death when many human beings are crowded together in close, ill-ventilated rooms.

When in such a state of concentration as not to pass the glottis, it produces instant suffocation, and if the person be not immediately removed from the obnoxious atmosphere, death ensues. But where it is diluted with atmospheric or other respirable air in sufficient quantity to be inhaled for a considerable time, symptoms closely resembling apoplexy are produced. This last casualty is most apt to occur from sleeping in a room with a charcoal fire, which has not a proper outlet for the gas, or in a green-house with plants, or even with a few flowers in a bedroom, above all from lime-kilns and brewers' vats.

When from any of these causes an individual has fallen into a state of stupor or insensibility, he is to be removed as speedily as possible into the pure fresh air, cold water should be dashed upon the face, ammonia may be rubbed upon the chest, and, if conveniences exist, he may be caused to breathe oxygen gas. Blood, but in moderate quantity, should be attempted to be procured from the arm or jugular vein, and efforts to effect this may be persevered in for hours with ultimate success.

Carbonic acid gas, diluted with a proper quantity of atmospheric air, has been advantageously employed, applied to limited portions of the body. Largely diluted, it has been recommended to be inhaled in the latter stages of phthisis pulmonalis, or consumption, to lessen the irritability, and remove the fetor of the breath arising from the morbid expectoration. It is in such cases merely a palliative. Children with hooping-cough are sometimes taken close to lime-kilns to breathe the carbonic acid gas—a very hazardous custom, as is also sleeping near lime-kilns for the warmth. When brought in contact with the mucous membrane of the stomach, it is often very serviceable; but if too strong, or its use is too long continued, it may give rise to alarming or unpleasant symptoms. The more speedy intoxication and headache which follow the use of the effervescing wines is due to the great quantity of carbonic acid gas which they contain. Even soda-water, if drunk in large quantity, may produce intoxication or headache.

The usual form of administering carbonic acid gas is either in some of the natural mineral waters, such as Seltzer, or by disengaging it from its combination with some alkaline base, such as carbonate of soda or potash: any acid given at the same time, by combining with the alkali, will liberate the gas. A vegetable acid, either the citric, in the state of lemon-juice, or tartaric acid, is commonly employed for this purpose; but in many instances sulphuric acid is preferable. Whenever great debility, or the phosphatic diathesis, as indicated by the state of the urine, exists, the use of a vegetable acid for the object above mentioned is prejudicial. (Prout, 'On Diseases of the Urinary Organs.')

The gas thus disengaged is of great utility in allaying irritability and spasmodic states of the stomach; thus it frequently checks vomiting, either simple, or even of blood.

In the irritable state of the kidneys and bladder which prevails in a phosphatic condition of the urine, water charged with a large portion of carbonic acid gas (but without any alkali) is of double utility, both from its sedative effect and its chemical properties of dissolving and holding suspended the phosphate of lime, and preventing it being deposited in the bladder. Externally water charged with carbonic acid gas has been employed as a wash or bath in many cutaneous diseases with good effect. The yeast poultice owes its soothing influence over irritable ulcers to the carbonic acid gas which is disengaged from it. A stream of carbonic acid gas has been proposed to be directed upon cancerous sores to allay the pain, and also upon burnt surfaces. But its employment in such cases requires caution.

CARBONATE, a salt composed of carbonic acid and a base. The carbonates are an important class of salts: some of them, as the carbonates of lime and magnesia, and the metallic carbonates, are

decomposed by heat; but the carbonates of potash and of soda do not suffer any alteration by exposure to it. For the various carbonates see the different alkaline, earthy, and metallic bases.

CARBONIC ACID (CO_2). There are two inorganic compounds of carbon and oxygen, namely, carbonic oxide, consisting of one equivalent of each of its elements, or six parts of carbon and eight of oxygen; and carbonic acid, formed of one equivalent of carbon and two equivalents of oxygen.

Carbonic acid was long known and observed to exist in various forms, and to be produced in different circumstances, before its nature was understood and its composition ascertained. Van Helmont recognised it as a peculiar matter, and called it *gas sylvestre;* Hales supposed it to be spoilt common air; Black gave it the name of *fixed air*, and made many curious and original experiments upon some of its compounds, showing that the causticity of the alkalies and lime depended upon its absence; Bergmann proved that it was an acid, and called it *aërial acid;* but Lavoisier first pointed out its true nature, and in consequence of his discovery it received the name of carbonic acid, which it still retains.

Carbonic acid exists largely in nature. It is in comparatively small quantity in the gaseous state in the atmosphere; it is in solution in most spring water, and in some called mineral waters to a considerable degree; but it is in solid combination that carbonic acid is found in the largest quantity, forming nearly 44-100ths of all limestones and marbles, besides occurring in less amount united with other earths and metallic oxides.

Carbon and oxygen do not appear to combine, or, if at all, very slowly at common temperatures, by direct action; but certain compounds which contain carbon, when undergoing the process of fermentation, yield a large quantity of carbonic acid. [FERMENTATION.]

It is also produced during the process of respiration; by animal and vegetable putrefaction; and by combustion, whether of oil, wax, tallow, vegetable matter, or coal.

Carbonic acid may be formed by the combustion of either charcoal or the diamond in oxygen gas; and it is found, that when 100 cubic inches of oxygen have combined with as much carbon or diamond as this quantity of gas is capable of taking up by combustion, there remains precisely as much in volume of carbonic acid gas as there was of oxygen employed. Thus 100 cubic inches of oxygen, weighing 34·4 grains, combine with 12·9 grains of carbon without any alteration of volume, and consequently 100 cubic inches of this gas weigh 47·3 grains, or its density is to that of atmospheric air as 1·526 to 1. By some chemists it is hypothetically regarded as composed of one volume of oxygen gas and one volume of the vapour of carbon, condensed into one volume. By weight it consists of

2 equivalents of oxygen	=	16
1 „ carbon	=	6
Equivalent	=	22

It contains twice as much oxygen as the bases which it saturates to form neutral carbonates.

When carbonic acid is required for experiment, it is usual to evolve it by decomposing a carbonate, rather than to form it by the combination of its elements as above described. For this purpose carbonate of lime, or chalk, or marble, may be put into a retort, and dilute hydrochloric acid being poured upon it, carbonic acid is plentifully given out; and although this gas is to a certain extent soluble in water, it may be received in jars filled with and inverted in water.

Carbonic acid gas is colourless and transparent, and therefore invisible; it has an acid and slightly astringent taste; it reddens litmus paper, but the blue colour returns as the acid volatilises. It extinguishes burning bodies, and is fatal to animals. On account of its great density, it diffuses slowly in the air, and hence it is apt to remain long in fermenting vats, old wells, &c., and has frequently produced fatal effects upon persons descending into them. Atmospheric air may however contain 1-20th of its volume of this gas, and be respired without becoming hurtful. On account of its great weight, it may be poured from vessel to vessel, as is shown by its extinguishing a taper repeatedly.

Carbonic acid, though gaseous at common temperatures and pressures, may be compressed into a liquid state, as shown by Mr. Faraday; and by the more recent experiments of M. Thilorier, it has been rendered even solid. Mr. Faraday's method of operating may be seen in the 'Phil. Trans.' for 1823. The liquid carbonic acid produced is limpid, colourless, extremely fluid, and refracts light less than water does. At 32° it requires a pressure of thirty-six atmospheres to retain it in a liquid state; in endeavours to open the tubes at one end, they always burst into fragments with a powerful explosion. M. Thilorier found that a jet of liquid carbonic acid received in a glass vial expanded to about 400 times its own volume, and by this produced so great a degree of cold, that one part of the carbonic acid congealed into a white powder, adhered to the glass, and retained its solidity for some minutes without pressure. Solid carbonic acid is now frequently made in large quantities by this process, and is employed for producing intense cold: by its aid mercury may be almost instantly frozen, even in a red hot vessel. [FREEZING MIXTURES.] It has already been mentioned that carbonic acid gas is soluble in water, and various contrivances have been adopted for impregnating water and saline solutions with it, to imitate natural mineral waters. Among these, Dr. North's apparatus is well known, and is described in most works on chemistry. At the average temperature and pressure, water takes up its own volume of carbonic acid gas, and under a pressure of two atmospheres it dissolves twice its volume, and so on. The water thus impregnated becomes brisk and tart, and reddens litmus paper: when the water is boiled, the carbonic acid is expelled. Carbonic acid is detected by the properties of extinguishing flame, proving fatal to animals, reddening litmus paper, but not permanently, and giving a precipitate with lime water; this precipitate is carbonate of lime, which is re-dissolved by an excess of carbonic acid, and re-appears when that excess is expelled by heat.

Carbonic acid, though in small quantity, always exists in the atmosphere, as may be shown by exposing lime-water to the air; the proportion does not usually exceed about one 2000th of the volume of the air; it is produced by the processes of respiration, combustion, and animal and vegetable decomposition, as already alluded to.

CARBONIC ETHER. [ETHYL.]

CARBONIC OXIDE (CO), commonly called also oxide of carbon, was first obtained by Dr. Priestley, but its nature and composition were determined by Mr. Cruikshank. Carbonic oxide may be prepared in various modes: first, by direct action; if charcoal be made red-hot in a gun-barrel, and oxygen gas from bladders be repeatedly passed over it, the oxygen is converted into oxide of carbon. Dr. Priestley procured it by heating together chalk and iron filings; in this case the iron takes half the oxygen from the carbonic acid of the chalk, and thus from a compound of two equivalents of oxygen and one equivalent of carbon, the residual gas, which is carbonic oxide, is constituted of one equivalent of each element.

Another mode of obtaining it with great facility, is to heat oxalic acid in a retort with sulphuric acid. Oxalic acid is a compound of three equivalents of oxygen and two of carbon; by the action of the sulphuric acid it is separated into carbonic acid and carbonic oxide, which are both evolved in the gaseous state; if the mixed gases be then passed through a solution of potash, the acid, being soluble in this liquid, is dissolved, and the carbonic oxide remains nearly pure. The best mode of procuring carbonic oxide is to heat a mixture of one part of ferrocyanide of potassium and nine parts of concentrated sulphuric acid in a capacious flask or retort; pure carbonic oxide soon begins to be evolved in very large quantity. Carbonic oxide is also produced, along with hydrogen, when steam is passed over ignited charcoal or coke; it is also an invariable constituent in coal gas, which contains on an average about 10 per cent. of this gas. The properties of this gas are, that it is colourless and insipid; it is but slightly dissolved by water; it is fatal to animals, and extinguishes a taper if immersed in it; but when it meets with oxygen gas it burns on ignition, and is converted into carbonic acid. It has no action upon blue vegetable colours; and, unlike carbonic acid, it does not occasion any precipitation in lime water.

Carbonic oxide is composed of

1 Equivalent of oxygen	=	8
1 „ carbon	=	6
Equivalent	=	14

It is hypothetically considered as constituted of 100 volumes of the vapour of carbon and 50 volumes of oxygen gas, condensed into 100 volumes. One hundred cubic inches weigh 30·1 grains; its density is therefore to that of atmospheric air as ·971 to 1. When electric sparks are passed through carbonic acid gas, confined over mercury, a portion of it is converted into carbonic oxide and oxygen gases.

CARBOVINIC ACID. [ETHYL.]

CARBUREIC ACID. A synonym for allophanic acid. [ALLOPHANIC ACID.]

CARBURET, or CARBIDE, a term designating a compound of carbon with certain other bodies, as nitrogen and some of the metals, &c.

CARBURET OF IRON. [STEEL.]

CARBURET OF NITROGEN. [CYANOGEN.]

CARBURETS OF HYDROGEN. [HYDROCARBONS.]

CARCASS, a shell, or hollow ball of iron, perforated in three places at equal distances from each other, within one hemisphere of the shell, and filled with a composition which burns with violence during eight or ten minutes. When discharged from a mortar or howitzer, the flames issuing from the perforations or fuze-holes set fire to any building on which the carcass may happen to fall.

CARD-MAKING. The name of cards is given to two kinds of manufactured commodities, so utterly unlike each other that it is difficult to conceive how it came to be so appropriated. One kind of card is a flat piece of pasteboard applied to many purposes of business or pleasure; the other is a series of sharp metal spikes set into a leather support, for carding or opening the fibres of cotton in the cotton manufacture. We shall describe the manufacture of both these kinds of cards, keeping them distinct, on account of their possessing no other connection than that due to the similarity of name.

Playing-cards. Neither the country nor the date of the introduction of playing-cards is correctly known, great diversity of opinion existing on both these points. It is believed that the figures and spots of the first cards were stencilled, and that the use of wood-blocks for printing them was of later introduction. It is known that there have been playing-card makers in this country for nearly four centuries. In India, cards are often made quite circular in form. In Russia, until within the last few years, the importation of playing-cards was strictly prohibited; there was an imperial manufactory kept up at Alexandroffski, near St. Petersburg, the profits being applied to the maintenance of the Foundling Hospital in that city. The manufactory contained many of the best forms of apparatus invented by De la Rue and Applegath; and the produce usually amounted to the enormous quantity of 14,000 packs of playing-cards per day.

The carton or pasteboard for playing-cards is formed of several layers of paper pasted together, each layer or sheet being large enough for forty average cards. The layers are four in number, all selected with especial reference to many requisite qualities, especially those for the face and the back. The pasting is very carefully conducted, and is followed by cool drying, hot drying, and heavy pressure. The outer surfaces undergo a peculiar treatment; if the cards are to be "white," the surface is furnished with a kind of flinty coating, in order that the black and red for the pips, and the varied colours for the court-cards, may come out clear and sharp; if they are to be "coloured backs," the ground tint is laid on by a regular colouring process, and the coloured surface is then further prepared for the reception of a pattern or device. The colouring material here spoken of is mixed with size and water, and applied with a brush. Messrs. De la Rue, who have carried this art to a higher pitch of excellence than any other English manufacturer, employ tasteful designers to produce elegant patterns for the backs of cards; and much mechanical and chemical skill has been displayed in devising new modes of colour-printing for this purpose. Some of the combinations of gold and colour are exceedingly beautiful. The number of cards in each pack is, as is well known, 52; but there have been exceptions to this number both in past and present times. The number of suits with us is always four, but in the East, and in Europe in earlier days, there were many instances of higher numbers. With us, the hearts, diamonds, spades, and clubs, are the only varieties; but in other days and countries there have been leaves, acorns, bells, cups, swords, batons, coins, pine-apples, heads, squares, ovals, circles, fishes, tortoises, lions, goats, horses, boats, axes, and other devices. Lastly, our court-, or coat- (as Mr. Chatto designates them), cards are now always kings, queens, and knaves; but the history of playing cards presents us with a curious medley of officers, subalterns, valets, virtues, heroes, savans, &c. The fixity of character in modern cards is certainly an advantage to the manufacturer; since he may make millions of packs without caring for any important modification. Messrs. De la Rue some years ago, spent a large sum of money, and much thought and labour, in an endeavour to introduce graceful figures instead of the monstrosities with which we are familiar under the names of kings, queens, and knaves; but the public had become accustomed to these latter, as to the conventional "willow-pattern" for dinner plates; and the attempt was abandoned at a heavy loss.

Most of the London card-makers employ the mode of stencilling, not printing, for the pips and pictures. A stencil-plate is cut out, and the colour, mixed with paste, is brushed on the sheet through the holes in the stencil-plate — a process requiring very nice manipulation, to prevent the colour from spreading beyond the margin of the stencil-holes. Some parts of the picture cannot be done by stencilling; they require the use of engraved wood blocks; and some manufacturers employ blocks altogether. Stencilling may be done on the paper either before or after it is pasted to other papers to make the cardboard; but the printed cards must be done before the pasting. The best cards are now printed in oil colours, on the principle of colour-printing of some other kinds—after the expenditure of much time and ingenuity in ensuring that the pip shall be equal-tinted, the outline clear and sharp, the colour well adhesive to the paper, the removal of all clamminess or stickiness, and the susceptibility of receiving a high polish. When the stencilling and printing have been completed, and the four thicknesses of paper properly pasted together, the cardboard is dried, polished, and rolled to a high degree of gloss. The ace of spades is printed under a wholly different and peculiar arrangement, to insure the payment of one shilling duty to Her Majesty on every pack of cards. Each carton or cardboard, having forty cards imprinted on it, is cut up into forty pieces by an apparatus similar to that used by bookbinders for cutting millboard. Every card is then minutely examined: and packs of fifty-two are made up from those which resemble each other as closely as possible in tint and general excellence. The strange technical names of "Mogul," "Harry," and "Highlander," are given to three qualities into which the cards are sorted; if they are not good enough for "Highlanders," they are thrown aside as waste cards. When the packs are arranged and made up, an exciseman attends to witness the wrapping in stamped papers.

A few years ago it was supposed that about 500,000 packs of playing cards were made in London annually.

It is not necessary to describe the manufacture of any other kinds of cards made of cardboard or pasteboard, such as visiting or address cards; seeing that they exhibit similar applications of some of the same operations as those described above.

Cards for Carding Engines.—In the cotton manufacture, one of the early processes consists in disentangling the fibres of cotton, so as to re-arrange them in a position more or less parallel, free from knots or other interruptions. The instrument employed for this purpose is a kind of brush called a "card," set with wire-teeth disposed in a regular manner. The action of this instrument is very similar to that of a comb for hair, or a heckle for flax and hemp, the fibres being made to pass between the teeth, or the teeth between the fibres, according to the arrangement of the mechanism. The wire teeth of the cards are inserted in carefully-prepared strips of leather, which used formerly to be affixed to flat handles or supports, but are at the present day bent round the exterior surface of a cylinder. Several such cylinders being arranged nearly in contact, and fibres of cotton being laid within reach of one of them, the cylinders by their rotation catch up the fibres, pass them on from one to another, and comb out or straighten them in the transit.

When the manufacture was in a ruder and less important position than at present, these cards were made by hand; the leather being dressed and cut, the holes pierced, the wire straightened and brought to the necessary shape, the teeth cut off and inserted into the holes in the leather, by persons who made this a regular branch of employment. But machines are now employed to effect this, so intricate and beautiful in construction as to have been often alluded to as among the most admirable pieces of mechanism known in our workshops and factories. It was in the year 1811, that Mr. Dyer, of Manchester, first took out a patent for one of these machines; two other patents were obtained in 1814 and 1824; and more recently further improvements have been made in the construction by Mr. Walton and other inventors.

The machine consists of a large number of levers or rods, capable of motion in various directions, and moving one after another in a particular and definite order. The different kinds of work to be performed by it are so numerous and so dissimilar, that the mass of details becomes exceedingly complex, and not easily followed even with the aid of wood-cuts. In the first place, the strips of leather which are to form the cards are attached to the machine, in such a way as to shift laterally as fast as they are supplied with wires. A series of forks or points are thrust out, to pierce holes of the requisite depth in the leather, and are drawn back again when this is effected; sliding pincers unwind the wire from a coil, and bring it forward; a moveable cutter descends upon each wire, and cuts off a piece long enough for one of the teeth; a blunt kind of stud or rod presses against the middle of the piece so cut off, and presses it into a horse-shoe or rather a staple-shape, with the two points parallel; each staple or tooth is seized by nippers, thrust half way into a hole in the leather, bent angularly by another piece of apparatus, so as to give an exactly determined obliquity to it, and lastly driven home to its proper depth in the hole. All this is effected by successive movements in the different parts of the machine; and several teeth, forming those in one row, are made and fixed at once. When one cycle or series of the processes is completed, the leather is made to shift onwards through a small space, and to present a new surface for the reception of teeth.

The efficiency of the machine was such, even some years ago, that a steam-engine of five-horse power could set a hundred of them at work, while each machine could make and fix from a hundred to a hundred and fifty teeth in a minute; but successive improvements have so increased the power, that now four or five hundred teeth are formed in the same space of time. There are not often opportunities of seeing these beautiful machines, except in the Lancashire and Yorkshire districts; but occasionally they are exhibited at Mechanics' and Scientific Institutions, and of late years at the greater international exhibitions.

So large is the consumption of this kind of 'garniture,' as it is called, for the carding-engines of the cotton districts, that—at a time when the cotton manufacture barely exceeded one-half of its present amount—it was estimated that four thousand hides and forty-eight thousand feet of wire were cut up weekly to make them. The wires are inserted in leather, because the flexibility of this material allows it to be bent round the surface of a cylinder. Patents have been taken out for improving the surface of these leathers. If a hard and tangled tuft of cotton occurs in the process of carding, the rigidity of the surface of the leather prevents the tooth from bending or yielding to the obstruction; and it has been proposed to remedy this by applying to the face of the leather, before the wires are inserted in it, a coating of woollen cloth, saturated with caoutchouc to render it very pliable. Another suggestion is for the use of a textile material, with a warp of hemp, flax, or cotton, and a weft of woollen, saturated in like manner with a solution of caoutchouc. But both are alike in their object, and have relation only to the minor working of the method, the card-making machine being independent of them.

CARDAMINE PRATENSIS—*Medical properties of.* This indigenous herbaceous plant decorates our meadows and pastures in April and May, with its light purple reticulately veined flowers, which are the officinal parts. They possess a faint mellifluous odour, which is nearly lost by drying. The taste is acrid and pungent, similar to but

less agreeable than that of the common watercress, which is dissipated by age. The chief constituents are a bitter extractive and a volatile oil. To these it is indebted for such medical powers as it possesses, which are very slight, altogether insufficient to entitle it to a place in the Pharmacopœia. It is said to be stimulating, diuretic, and anti-spasmodic; and hence of service in hysteria, chorea, and epilepsy. In some of the slighter cases of these, dependent on irritation of the intestinal canal, from imperfectly digested food, unhealthy secretions, or worms, it may, along with purgatives, bitters, and exercise, be of some benefit. It is however as an anti-scorbutic herb that it is best entitled to notice. The health of many persons is low in early spring from the want of green vegetables during winter, and the blood passes into the condition which obtains in persons suffering from scurvy. The use of fresh vegetables, such as this and watercresses, with fruits and lemon-juice, will speedily remove this state.

(Lecture of Dr. Budd on *Scurvy*, in *London Medical Gazette*, vol. xxxii. p. 713.)

CARDAMOM, *Essential Oil of*. This oil is obtained by distilling cardamom seeds with water. It is colourless, possessing a strong aromatic taste, and an agreeable odour. Its specific gravity is ·943. It has the same composition as *camphen*, namely, $C_{10}H_8$.

CARDAMOMS are the aromatic capsules and the seeds of different species of several genera of plants formed out of the original genus *Amomum* of Linnæus. They are all natives of the hotter parts of the world, the respective kinds being distinguished in commerce either by their form, or designated by the names of the countries or provinces whence they are supposed to come. The genus *Elettaria* (*Rheede Matonia* of Smith, in Rees' 'Cyclop.') yields the only kind of cardamoms admitted into the present (edition 1851) 'London Pharmacopœia.' Besides these, several are known in Continental commerce under the name *Amomum*, which have neither the characters nor qualities of true cardamoms. Thus, the *Sison Amomum*, the *Hedge Honewort*, or *Bastard Stone Parsley* of our hedges, called *German Amomum*, yields a fruit (erroneously called *seed*) which, when dry, is aromatic, pungent, and pleasant, but when fresh is more calculated to disgust and repel than attract. Likewise the fruit or unripe berries of the Eugenia (*Myrtus*), pimento berries, allspice, or Jamaica pepper, are called in Germany *Semen Amomi*, or *Baccæ Amomi*. But as they are aromatic stimulants, like cardamoms, any possible confusion of them is of less consequence. In giving an account of the appearances and supposed sources of cardamoms, the authority most to be depended on is the late Dr. Pereira, who has taken great pains in investigating this subject. (See his 'Elements of Materia Medica,' last ed., 1850, p. 1129, and various papers in earlier volumes of the 'Journal of the Pharmaceutical Society.')

1. The cluster or round cardamoms yielded by *Amomum cardamomum* of Linnæus, supposed to be the ἄμωμον of Dioscorides (lib. i. cap. xix.), the *Amomi uva* of Pliny ('Hist. Nat.,' lib. xii. cap. xxviii.), a native of Sumatra, Java, and other islands to the eastward of the Bay of Bengal. The fruit varies in size from that of a pea to a cherry. When they occur in their native clusters or spikes, they constitute the *Amomum racemosum*; when distinct, simply round cardamoms. The seeds are brown, angular, wedge-shaped, somewhat shrivelled, with an aromatic camphor-like flavour. These are more employed in the South of Europe than with us, but they are officinal in the French Codex and the Dublin Pharmacopœia. They posesss, though in less degree, the qualities of the Malabar cardamoms.

2. *Amomum Granum Paradisi*, Afzel. et *A. Melegueta*, Roscoe.—The name *grains of paradise* are given to the seeds of the two species of Amomum cited here,—called also Guinea grains, while Malagueta pepper is given to the latter only; yet the term Malagueta pepper is also given to the fruit of the Eugenia pimenta. *Maniguette* is likewise sometimes given as a name to the *grains of paradise*; but this is properly the designation of the fruit or seeds of *Unona æthiopica*, called, from its pungent qualities, *Piper æthiopicum*, but not a species of the genus *Piper*.

The two sorts of seeds to which the term *grains of paradise* should be restricted grow in Africa, probably widely apart, as they find their way to different parts of the coast, and are held in commerce to be very different in value.

Amomum Granum Paradisi, Afzelius, and Smith (in Rees' 'Cyc.,' vol. xxiii., art. 'Mellegetta;' and vol. xxix., suppl., art. 'Amomum'), native of Guinea, about Sierra Leone. The capsule is about an inch long, half an inch in diameter, oblong, bluntly triangular, somewhat ovate, beaked, of a dark reddish-brown, ribbed, coriaceous, rough, with minute deciduous bristly hairs. This, when broken, gives a powerful aromatic odour, which it retains even for twenty years. The seeds within are numerous, enveloped in membranes formed of the dried pulp; when freed from this they appear roundish or angular, of a shining golden colour inclining to brown; when old, minutely rough or granulated; when bitten, extremely hot, acrid, and pungent.

The *Amomum Meleguetta* (Roscoe) is cultivated in Denmark, probably introduced from Africa. The seed-vessel and seeds are larger than those of *A. Granum Paradisi*.

In commerce the two sorts are distinguished as: 1. Guinea grains from Cape Palmas and Sierra Leone, supposed to be the produce of *A. Granum Paradisi*; less esteemed than—2. Guinea grains from Acra; larger and plumper than the preceding, as well as more warty. They

have also on the umbilicus of the seed a short, conical, projecting tuft of pale-coloured fibres. Considered to be the produce of *A. Meleguetta* (Roscoe).

The chemical composition of grains of paradise, according to the analysis of Willert, in 1811, appears to be—

Volatile oil	0·52
Acrid resin	3 40
Extractive	1·27
Tragacanthine and woody fibre	82·8
Water and loss	12·0
	99·99

The active constituents are the volatile oil, which is of a light yellow colour, with camphor-like odour, and very hot penetrating taste, and the resin. This is soft, brown, devoid of odour, but with an acrid burning taste.

While the native Africans justly esteem these fruits and seeds as the most wholesome of aromatics, and employ them in many of their dishes, prejudice restricts the employment of them in England, either as veterinary medicine or as an ingredient in liqueurs or cordials, their use for which is absurdly prohibited by heavy penalties. Being exempt on the Continent, large use is there made of them. (Jullien, 'Manuel du Sommelier.')

Amomum maximum (Roxb.), yields the greater Java cardamoms, the Nepaul cardamoms, and Bengal cardamoms. These are easily distinguished by immersing the dried capsules in hot water, when they immediately swell, become globular, and evolve from nine to thirteen elevated ridges terminating in their membranaceous wings. The seeds are larger than those of grains of paradise, and have a dull dirty brown hue. The taste and odour are only feebly aromatic, and they contain far less volatile oil, which is whitish. They are chiefly exported from this country in bond, for use on the Continent.

The *Amomum Korarima* yields the *Cardamomum majus* of Valerius Cordus, a still feebler species. The term *Cardamomum majus* has also been given to the fruit of an unknown species, which Dr. Pereira has proposed to call *Amomum citratum*, from the agreeable lemon grass-like odour of the seeds. These have sometimes been termed Grains of Paradise, but the seeds appear larger than the common ones.

The *Amomum Clusii* deserves notice, not only because the seeds receive the name of "Bastard Melligetta" from the natives around Fernando Po, where they are abundant, but on account of the use made by them of the pulp in which the seeds are imbedded. This is of a soft consistence, acidulous, and of a pleasant flavour. Either alone, or diluted with water, this natural compound has a most beneficial effect in allaying thirst or soothing the intestinal canal when irritated by purgatives or disease, such as dysentery. Similar natural combinations are used by the natives of various hot countries; such as the pulp of the *Adansonia digitata* in Senegal, and the *Tamarindus Indica* in the East Indies, and *Tamarindus occidentalis* in the West.

Amomum macrospermum (Smith; *Zingiber Meleguetta*, Gærtner), only deserves notice as having been erroneously asserted by Trew to produce from its seeds the Cajuput oil of commerce. Though a native of Sierra Leone, the fruit is termed sometimes *Cardamomum bandaense*. The natives suck the acidulous juice of the capsule.

The *Eletharia cardamomum* (Maton), yields the true or officinal cardamom, called likewise Malabar cardamom. The fruit and seeds are officinal. The seeds are more potent when kept in the capsule till about to be used. They are either collected from wild plants or cultivated,—the best from the latter, especially such as are produced at Wynaad. The wild plants are so abundant in the Ghauts of Cadutinada, and near Mahé, that the hills are called the Mountains of Cardamoms (Fee). The capsules occur in commerce in three forms,—*shorts*, *short-longs*, and *long-longs*. The shorter are the most esteemed; they are probably collected earlier than the others, and while possessed of more aromatic pungent flavour. According to the analysis of the shorts by Trommsdorff, in 1834, they contain—

Essential oil	4·6
Fixed oil	10·4
A salt (malate?) of potash, with colouring matter	2·5
Starch	3·0
Nitrogenous mucilage, with phosphate of lime	1·8
Yellow colouring matter	0·4
Woody fibre	77·3

The volatile oil is the active ingredient. Cardamoms are perhaps the best and most esteemed of all aromatic stimulants; they enter into various pharmaceutical compounds, especially two tinctures, a simple and compound one. It is an ingredient in many dishes in the East, especially curries. [CURCUMA.]

CA'RDINAL, the highest dignity in the Roman Church and court, next to the pope. The cardinals are the electors of the pope, and his councillors.

The term is derived from the Latin adjective "cardinalis," which means "principal," or from the substantive "cardo," which means a "hinge," the cardinals being the hinges or supports of the Church, and

the pillars of the Roman clergy. There were also cardinal deacons, who had the charge of the hospitals for the poor, and who ranked above the other deacons. Originally, this title appears to have been applied to the highest offices, but about the 11th century it became restricted to the incumbents of the parishes of the city of Rome, and also of other great cities, who alone had the power to baptise and to administer the Lord's Supper. The cardinal priests of Rome attended the pope on solemn occasions. Leo IV., in the council of Rome, 853, styled them "presbyteros sui cardinis." Afterwards the title of cardinal was given also to the seven bishops suburbicarii, or suffragan of the pope, who took their title from places in the neighbourhood of Rome; namely, Ostia, Porto, Santa Rufina, Sabina, Palestrina, Albano, and Frascati. These bishops were called hebdomadarii, because they attended the pope for a week each in his turn. The cardinals took part with the rest of the Roman clergy in the election of the pope, who was often chosen from among their number, till 1058, when, having chosen Nicholas II. without the participation of the people, the right of doing so was decreed by the pope in the following year; and in 1179, the election was more solemnly restricted to the cardinals only by Alexander III. About the beginning of the 12th century, the popes having organised a regular court, bestowed the rank of cardinal priest or deacon on any individual of the clergy or even laity that they thought proper, whether Roman or foreign, giving to each the title of some particular church of Rome, without any obligatory service being attached to it. The churches which give titles are, however, even yet, under the complete jurisdiction of their respective titulars. Thus they made the cardinals a separate body elected for life; and the officiating priests of the Roman parishes were by degrees deprived of the title of cardinals. Sixtus V., in 1587, fixed the number of cardinals at seventy, which has been since increased to seventy-two; namely, the six bishops suburbicarii above-mentioned (the title of Santa Rufina being joined to that of Porto, and that of Velletri added to Ostia), fifty-two cardinal priests, and fourteen deacons. Most of the cardinals, both priests and deacons, bear the title of a church of the city of Rome. Several of the cardinal priests are bishops of some particular diocese at the same time; still they bear the title of the particular church of Rome under which they were made cardinals. The body of the cardinals is styled the Sacred College. The number of seventy-two is seldom complete, the pope generally leaving some vacancies for extraordinary cases. Most of the cardinals who reside at Rome, either enjoy ecclesiastical benefices, or are employed in the administration, either spiritual or temporal; others belong to wealthy families, and provide for their own support; and those who have not the same means, receive an allowance from the government. Their dress, adopted before the commencement of the 13th century, was a scarlet or violet robe and nose, symbolising their readiness to shed their blood for the Catholic faith. In 1243, Innocent IV. gave them the red hat, and precedence over bishops; Boniface IV. added the princely mantle, and Urban VIII. gave them the title of "Eminence." The nomination or promotion of any one to the cardinalate rests wholly with the pope; and their institution is accompanied by the ceremony of kissing the pope's foot, hand, and mouth, and by others symbolical of their spiritual allegiance. The pope often employs cardinals as his ambassadors to foreign courts, and the individual thus employed is styled Legate *a Latere*. A cardinal legate is the governor of a province, known by the name of a Legation, whereof, till the revolution of 1830, there were four. The chief secretary of state, the camerlengo or minister of finances, the vicar of Rome, and other leading official persons, are chosen from among the cardinals.

The Council of Cardinals, when assembled under the presidency of the pope to discuss matters of Church or state, is called "Consistorium." There are public consistories, held on some great occasions, which correspond to the levees of other sovereigns, and private or secret consistories, which are the privy council of the pope. With regard to the forms of the election of a pope, see CONCLAVE.

In Moreri's Dictionary, art. "Cardinal," is a list of all the cardinals elected from 1119 till 1724, their names, countries, titles, and other dignities, the date of their election, and that of their death, which may be found useful for historical reference.

CARDINAL POINTS. [COMPASS.]

CARDING. [WOOLLEN MANUFACTURES.]

CARDI'TIS, inflammation of the heart. [HEART, DISEASES OF.]

CARILLON. [CHIMES.]

CARMIDINE. An organic base found in shale tar. It has hitherto only been imperfectly examined.

CARMINATIVES, agents chiefly obtained from the vegetable kingdom, are employed to promote the expulsion of flatulence. Though gases of different kinds are occasionally secreted by the inner surface of several organs of the body, those gases which infest the intestinal canal are in a great measure the result of the fermentation of articles of food, the digestion of which is slow or imperfect. Whatever causes indigestion favours the formation of such gases; hence they mostly trouble infants, whose stomachs are generally feeble, or hypochondriacal and hysterical individuals, or those who lead a sedentary life. Substances which impart, even for a very short time, that energy and power which, in such persons, the stomach and intestines appear to be destitute of, enable them to throw off the wind which oppresses these organs. Plants possessed of an aromatic principle, owing to the presence of a volatile oil, are employed to effect this end, which they sometimes accomplish even when applied to the external surface of the stomach, and much more certainly when taken internally. Instead of the plants in a raw or dried state, the oil is often extracted from them by distillation, or a tincture or even a distilled water is formed from them, and administered under similar circumstances; and this last mode is in general the best. A few drops of the oil, or of the tincture of any of these plants, may be dropped upon sugar, and so introduced into the stomach, or the distilled water may be made the vehicle for the administration of other medicines proper to be given at the same time. Thus some alkaline earth, such as magnesia or its carbonate, or a pure alkali, such as liquor potassæ, or an alkaline carbonate, may be given at the same time with good effect.

As a general rule, it may be stated that, if these stimulants fail on their first exhibition to give the relief expected, they should not be repeated without the sanction and advice of a competent medical attendant; for, even if an inflammatory condition of the stomach and intestines does not already exist, the continuance of colicky pains is apt to produce it, especially if assisted by brandy or other stimulants. Even dill or anise may affect too powerfully the sensitive nervous system of infants, for these are by no means such simple agents as is commonly supposed: the seeds of dill poison bullfinches, canary birds are killed by those of anise, and parrots by those of parsley.

The safest and most effectual means of avoiding the distressing symptoms attendant on the disengagement of flatus are great attention to diet and regimen. Regular exercise should be taken daily. The food should be plain; soups and much liquid, particularly tea, should be avoided: and the person should retire to rest at an early hour. [AROMATICS, ANTISPASMODICS.]

CARMINDIN. [INDIGO.]

CARMINE, as met with in commerce, consists of the colouring matter (*carminic acid, cochenillin*) of the cochineal insect (*Coccus cacti*, ord. *Hemiptera*), united generally with alumina, sometimes with oxide of tin, and occasionally it contains albumen, on account of white of egg having been used in its manufacture. The following are some formulæ for the preparation of this beautiful pigment:—

One pound four ounces of cochineal and 115 grains of carbonate of soda are to be boiled with four gallons of rain-water, or, better, distilled water, for twenty minutes; and, after removing from the fire, three-quarters of an ounce of alum and the eighth of an ounce of bitartrate of potash are to be added, and the whole well stirred. On standing, impurities subside, and the liquor may be carefully decanted off and strained if necessary. It will now soon become turbid, when the whites of two eggs, well beaten up, are added, and if complete separation of the colouring matter does not immediately take place the whole may be gradually heated, when the carmine soon rises to the surface. The liquor should not be boiled. Collected on a strainer, the carmine, after washing with three or four pints of water, is to be dried at a temperature between 82° and 86° Fahr. Isinglass may be substituted for white of egg if a less granular carmine is desired.

In the preparation of carmine, great delicacy of manipulation and perfect purity of material is necessary; the heat required should be generated from a charcoal fire, and all vessels kept scrupulously clean; even the atmosphere of a large town is said to injuriously affect its tint.

Carmine is largely used in miniature painting, artificial-flower making, perfumery, confectionery, red ink manufacture, and as a cosmetic, sometimes called rouge, for the complexion. It is richer, more transparent, and a smaller quantity goes further than any other colour of similar hue.

Carminic acid (*cochenillin*), ($C_{28}H_{14}O_{16}$), is the pure colouring matter of the cochineal insect mentioned already. Mr. Warren De la Rue, who has made an elaborate investigation of this substance, recommends the following process for its preparation: An aqueous decoction of the powdered cochineal is to be precipitated with acetate of lead, the washed carminate decomposed by a stream of sulphuretted hydrogen, and the carminic acid again precipitated with acetate of lead previously mixed with acetic acid. The carminate of lead is once more decomposed with sulphuretted hydrogen, the solution evaporated to dryness, re-dissolved in alcohol and phosphoric acid, and separated by digesting the tincture with a small quantity of carminate of lead. Lastly, a trace of nitrogenous matter being separated by ether, the pure carminic acid is obtained from the filtrate by evaporation.

Carminic acid is a purple-brown friable solid, transparent under the microscope. It is easily ground to a fine red powder. It is very soluble in water and alcohol, and in hydrochloric and sulphuric acids; but only slightly so in ether. Chlorine, iodine, and bromine decompose it. It may be heated to a temperature of 245° Fahr. without injury; a higher heat causes decomposition. Nitric acid very readily attacks it, a mixture of oxalic and nitrococcusic acids being produced. [NITROCOCCUSIC ACID.] The alkalies combine with carminic acid, forming rich purple colours, soluble in water, but not in alcohol. The alkaline earths produce purple precipitates, and sulphate of alumina and ammonia carries down a beautiful crimson lake from solutions of this acid. It may also be made to combine with lead, copper, zinc, and silver.

CARMINIC ACID. [CARMINE.]

CARMUFELLIC ACID ($C_{24}H_{20}O_{32}$). An organic acid, said to be

obtained by the action of nitric acid upon the aqueous extract of cloves.

CARNIVAL, or CARNEVAL, from the Italian *Carnevale*, or Farewell to Flesh. It is properly a season of feasting, dancing, masquerading, and buffoonery, which begins on the Feast of the Epiphany, or Twelfth Day, and ends on Ash-Wednesday, when it is succeeded by the austerities of Lent. Some of the licence of the Saturnalia of the ancient Romans is still detected in these long revels, which are now confined to Roman Catholic countries, and seem to be declining even in them. Milan, Rome, and Naples were celebrated for their carnivals, but they were carried to their highest perfection at Venice,

> The pleasant place of all festivity,
> The revel of the earth, the mask of Italy.

In modern Rome, the masquerading in the streets and all the out-of-door amusements are limited to eight days, during which people pelt each other with sugar-plums, and are treated with horse-races, in which horses run without any riders on their backs. After the races of the eighth day, masquers go about with tapers in their hands, every one trying to light his own at his neighbour's candle, and then blow out his flame. This is the last of their frolics, and about as rational as any part of a Roman carnival. Göthe, in his 'Zweiter Romischer Aufenthalt,' has given a vivid and pleasing description of the Roman carnival.

CAR'OL (*Carola*, Ital.), a song of joy, and we use it in this sense when we speak of the carolling of birds. Boccaccio seems to have considered the term as synonymous with *ballata*, which, according to the dictionary *Della Crusca*, signified a song sung during a dance. In England the term was formerly given to festal songs sung to celebrate Christmas; but it is now exclusively applied to a religious song or ballad in celebration of Christmas, still sung during the festive season in many parts of the country, though in the present day seldom heard in the metropolis.

CAROTIN ($C_{10}H_8$) the colouring matter of the common carrot, *Daucus Carota*.

CARPENTRY is defined by Robison as "the art of framing timber for the purposes of architecture, machinery, and in general for all considerable structures." Considered as a branch of the art of building, it embraces the construction of the framing of partitions, floors, and roofs; the neater woodwork of doors, window-frames, the planking of floors, skirtings, and stairs, being the work of the joiner. [JOINERY.]

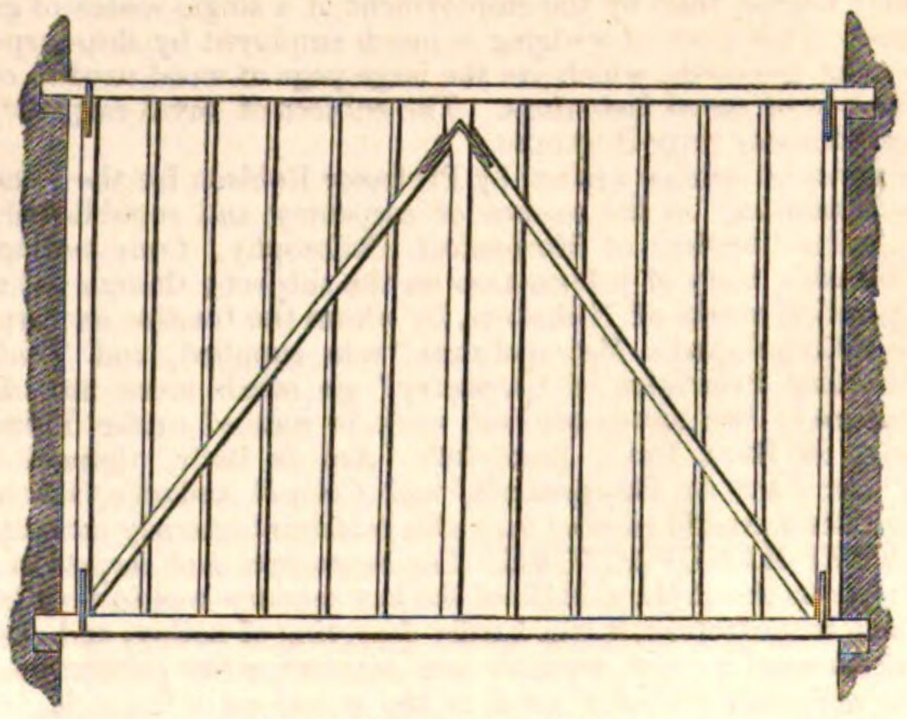
As in the article BUILDING, our object here is rather to point out and connect various articles in other parts of the Cyclopædia, than to present even a complete outline of the theory and practice of carpentry; seeing that such a subject would involve a knowledge of the nature and properties of various descriptions of timber—of the strength of materials exposed to various kinds of strain—of the mechanical principles involved in the construction of trusses, roofs, and the various framings which tend to bind the several parts of a building together, or to sustain and distribute pressure—and of the practical details relating to the cutting up of timber, and the union of several pieces by various kinds of joints and connections.

Of the properties of timber an account is given under WOOD; and also, in connection with other matters relating to theoretical carpentry, under MATERIALS, STRENGTH OF. Of the woods used in carpentry in this country, oak is one of the most durable, though its comparatively high price, and the difficulty of working it, restrict its use. It should be borne in mind however, that the irregular direction of the fibres of oak greatly impairs its strength when sawn into beams and planks, so that a sawn beam of oak may be weaker than one of equal size of fir, because in the latter the fibres extend in almost perfectly straight lines from end to end, while in the former their course is so tortuous that those which come near the surface are frequently cut through by the saw. Hence arises the superiority, for some purposes, of split over sawn timber. Fir, which is very easy to work, and is peculiarly advantageous for house carpentry on account of its straightness, is the timber most extensively used by English carpenters. The supply is chiefly from foreign countries, and the principal forms in which it is brought are those of *baulks*, or large beams of various sizes, each of which consists of a whole trunk roughly squared; *deals* and *deal-ends* [DEALS], which are boards from $2\frac{1}{2}$ to 4 inches thick, and more than 7 inches wide; and *battens* and *batten-ends* [BATTENS], which are similar to deals, but only 7 inches wide. Various technical terms are applied to the smaller pieces of timber cut out of baulks, deals, and battens, the transverse dimensions of which are frequently called their *scantling*. By the drying up and evaporation of its vegetable juices, timber will continue to shrink for a considerable time after it is hewn, and in so doing it frequently warps or winds, and splits, or becomes *shakey* or full of longitudinal cracks, which are usually in a radiating direction as regards the centre or heart of the tree. The shrinkage alluded to is almost entirely in a lateral direction, the length of a piece of timber, in the direction of its fibres, being affected only in a very trifling degree. To prevent as far as possible the injurious effects of shrinking, warping, and flying or cracking, timber should be well seasoned by long exposure to a current of air before it is used, an object which is effected by various modes of stacking and piling with interstitial openings for the admission of air; but as no ordinary amount of seasoning will perfectly accomplish the desired object, precautions

should be adopted to lessen the evil of subsequent shrinkage. Where it is required to bend timbers they are softened by boiling or steaming, or by the direct action of fire, then brought to the required shape, and secured at the proper curvature until they become cold and dry, when they will retain their new form with very little variation. For the various modes of cutting timber see the articles SAW, SAW-MILL, and WOOD-CUTTING MACHINERY; and for a notice of the principal boring tools used by the carpenter, see BORING INSTRUMENTS.

Of the employment of timber in immediate connection with brickwork, as in bond-timbers, wall-plates, camber beams over doorways and windows, &c., a notice will be found under BUILDING; and in the articles ROOF and FLOOR, will be found most of the information required in a work of this character on carpentry, as connected with building. In ROOF especially, and in the account of centering under that head, an explanation is given of those elementary principles of trussing, or combining several pieces of timber into a rigid framework in which the strength of each of them is used to the greatest advantage, which must be applied, with such modifications as circumstances may dictate, to almost every construction in carpentry; while under TRUSSING, the application of the same principles to the support of large beams or girders is explained. The construction of timber partition-walls, or rather of the timber framing of such partition-walls, as are covered with lath and plaster, though based on the same general principles as are involved in the trusses of a roof, may be noticed here, because, though a distinct branch of carpentry, it does not, like the construction of floors, demand a separate article.

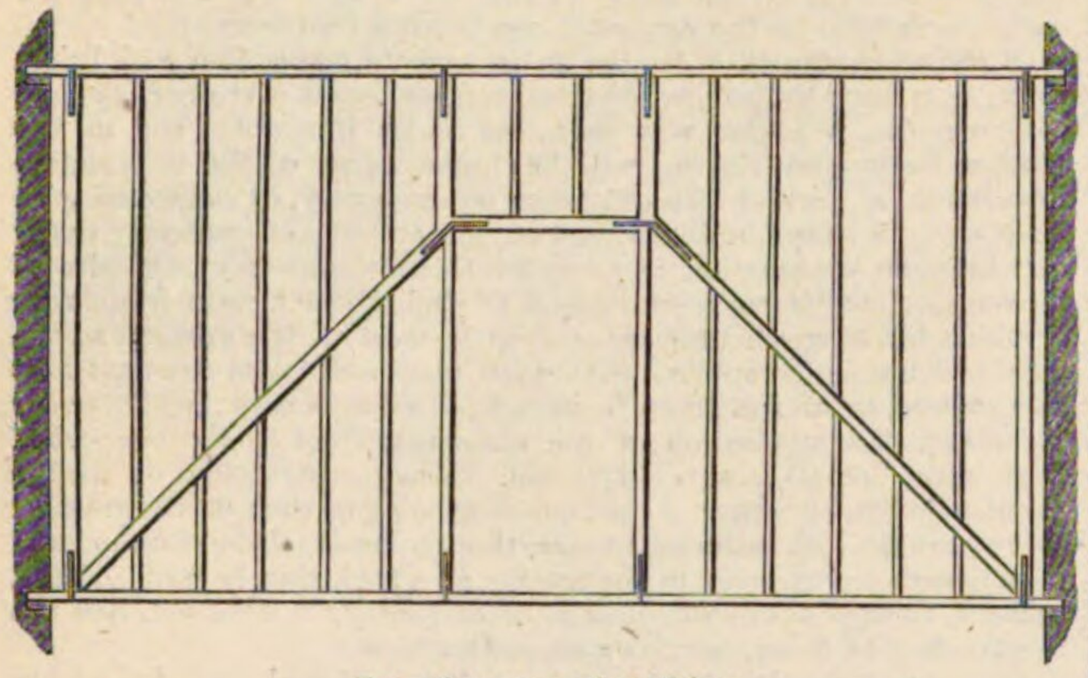
Partitions formed of brick-nogging, or of brickwork included within the intermediate spaces of a timber framing, are noticed under BUILDING; and as, from their weight, they are inapplicable excepting in cases where there is a solid bearing or foundation for the whole length of the partition, as in basement partitions, or in such partitions of upper rooms as are immediately over partition-walls rising from the basement, they call for but little skill in the arrangement of the timbers. In the construction of such partitions, or of ordinary lath and plaster ones, which are sometimes called (from the use of small timbers denominated quartering) *quarter partitions*, wherever they rest upon a solid basis, it is sufficient to fill the rectangular framing which bounds the partition at the sides, top, and bottom with a series of upright rectangular bars, the greatest width or thickness of which is disposed in a direction at right angles with the face of the partition. These upright timbers, or quarterings, are placed at uniform distances from each other, the intervening spaces being, in a brick-nogging partition, either eighteen or twenty-seven inches, so as to receive either two or three bricks in length, while in other cases they are usually less, or from twelve to fourteen inches, according to the strength of the laths used upon them; and the depth of the quarterings, which regulates the thickness of the partition, is usually from three to five inches. Those for brick-nogging, where the surface is to be covered with lath and plaster, should somewhat exceed the thickness of the brick-work, so as to allow for irregularities in the form of the laths. When, however, the floor upon which the partition rests is not solid, but is unsupported in the centre, the whole stress should be borne by the extremities of the lower edge of the partition, and this should be constructed as nearly as possible like the trusses of a roof, and should be capable of affording support to the floor above it, and also, if needful, to that below it, on which it appears to rest. The simplest mode of accomplishing this is to insert in the frame two inclined bars or struts, resembling rafters, abutting upon the lower corners of the partition, which struts of course must be firmly supported by the timbers of the floor at the point where they rest upon the wall-plates, or are otherwise immovably connected with the brickwork, and either meet in the centre of the top of the partition, or be framed into the head of a central upright timber resembling a king-post, which, like it,



Framed king-post partition.

may be made to assist in supporting the middle portion of the bottom of the partition, and, if needful, the floor beneath it also. In either

case, the point of meeting becomes a fixed point for supporting the ceiling or floor above it. If the length of the partition be too great for this arrangement, or if a doorway be required where the central post would come, two posts may be used instead of one, with an horizontal bar of wood between their upper ends; or, in fact, a queen truss may be formed. The diagonal bars are called *braces*, and the



Framed queen-post partition.

horizontal piece between the posts is sometimes called an *intertie;* but these names are objectionable, because the action of the pieces in question is the reverse of that of a tie, or of what would be generally understood by a brace. Doorways often derange the bracing of partitions, and sometimes render it impossible to retain the advantage of the tie afforded by the bottom piece of the rectangular frame which bounds the partition. In some cases the intertie, or rather collar-beam forms the head of the doorway; but as the doorway is mostly much lower than the partition, it is not unusual to extend the horizontal piece which forms the head of the doorway to the extent of the whole length of the partition; it is also usual to form the long rectangular space above it, and the rectangular spaces below it on each side of the doorway, or the whole space below it, including the doorway, into separate trusses. The long unbroken truss above the doorway may indeed be made to support the whole partition without the aid of bracing in the lower compartments. Sometimes, instead of the ordinary mode of bracing, which necessarily interferes with the fixing of the upright quarterings to which the laths are to be attached, a mode of bracing with parabolic arches of iron or wood is adopted. The usual mode of bracing is occasionally used for brick-nogging partitions, or, in rural cottages, for the brick-nogging of external walls; but of course its adoption occasions much trouble in cutting the bricks to fit the oblique lines and angles produced by the braces.

Respecting the various kinds of joints required in carpenter's work, information will be found under ROOF and SCARFING. Robison mentions an ingenious modification of the common mortise-and-tenon joint which is worthy of notice, under the name of *fox-tail wedging*. It consists in the insertion in the end of the tenon of a thin wedge, which, when the mortise is not cut through, but simply into, the piece of wood in which it is formed is forced into the tenon, and consequently imparts to it somewhat of the dovetail form, by the mere act of driving the tenon into its place. Robison suggests that, to guard against the liability of the tenon to split beyond the shoulder, the required effect may be better produced by the use of several very thin wedges, which will collectively enlarge the end of the tenon in the necessary degree, than by the employment of a single wedge of greater thickness. This mode of wedging is much employed by ship-carpenters in securing tree-nails, which are the large pegs of wood used in certain cases in lieu of metal fastenings. The subject of naval carpentry will be treated under SHIP-BUILDING.

The series of articles written by Professor Robison for the 'Encyclopædia Britannica' on the science of carpentry, and republished, with notes, in his 'System of Mechanical Philosophy,' form perhaps the most valuable body of information on the subject; though the numerous practical works of Nicholson, by whom the treatise on carpentry in the 'Encyclopædia Metropolitana' was supplied, and Tredgold's 'Elementary Principles of Carpentry,' go much more into details. The nature of the last-mentioned work is noticed under TREDGOLD, THOMAS, in BIOG. DIV. Rondelet's 'Art de Batir,' Colonel Emy's Essay 'sur l'Art de Charpenterie,' and Colonel Ardant's 'Études sur les Combles à grande portée,' may also be advantageously consulted.

CARPET MANUFACTURE. The consumption of carpets in Great Britain up to about the middle of the last century was so very trifling, that, as a manufacture, it was hardly deserving of notice; and although now so essential to our warmth and comfort, a few generations since carpets were only partially used in the mansions of the rich. Only a few manufactories, of which that at Wilton was the most important, existed in different parts of the kingdom; and at Kidderminster, which is now one of the principal seats of the trade, the carpet manufacture did not commence before the early part of the 18th century. At

Halifax, where the trade is very extensive, the introduction of the manufacture was much more recent.

In presenting here some account of the manufacturing processes, it may be well to premise, that in all, or nearly all, kinds of carpets the materials are dyed before they are put into the loom. A very curious and ingenious attempt was made some years since to print the worsteds while in the process of weaving. A patent was taken out, and the object was partially accomplished, but there are so many difficulties to encounter that this plan has not been brought into general use.

The following are the chief kinds now made in Great Britain: Axminster, Venetians of different sorts, Kidderminster or Scotch, British or damask Venetian, Brussels, and Wilton or pile carpeting. These names do not always denote either the present or original place of manufacture. Brussels carpets were introduced into Kidderminster from Tournay in 1745; and we do not know that Venetians were ever made at Venice. Wiltons (which are in fact Brussels carpets) were made on the Continent before they were introduced at Wilton; and what are called Kidderminster are made in the greatest quantities in Scotland or Yorkshire.

Axminster carpets must be included among those which no longer correspond with their name. At Axminster, in Devonshire, a manufactory of expensive carpets was maintained for more than a century; but it has now been abandoned. Axminster carpets (supposing them to be really now made) are usually made in one piece, according to the dimensions of the room for which they are required. The warp or chain is of strong linen, placed perpendicularly between two rolls or beams which turn round and enable the chain to be rolled from off one beam and on to the other as the weaving of the carpet proceeds. Small tufts or bunches of different coloured worsted or woollen are tied to or fastened under the warp; and when one row of these tufts has been completed, the shoot of linen is also thrown in and firmly rammed down. Another row of tufts is then arranged in such a manner as, by a change of the colours, to form a further portion of the pattern. To guide the weaver as to the position of the colours, a small paper design or drawing constantly hangs before him, from which he works. The tedious nature of this process, and the quantity of materials which it consumes, render this kind of carpet very expensive; and few, if any, are now made.

Real Turkey carpets (so called to distinguish them from those Brussels, the patterns of which are made to imitate them) are manufactured in a similar manner to Axminster carpets; they are regularly imported, though not in very large quantities. *Finger* and *Stormont rugs* are also formed with tufts, introduced in a similar way; but the warp or chain is laid horizontally, and a common loom, with its usual appurtenances of treadles, gearing, reed, lathe or batten, &c., is made to assist in the process. In all these carpets the warp and weft, or, as they are called, chain and shoot, which are both of linen, are altogether concealed from the upper surface, the tufts of worsted or woollen being the only part that is visible.

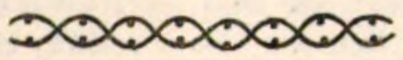
Venetian carpets.—Here the warp or chain, which is of worsted, and generally arranged in stripes of different colours, is alone visible; the shoot, which is of a dark colour and usually black, is concealed between the upper and under surface. By using shoot of different sizes, these carpets are sometimes made to assume the appearance of plaids or checks; and by the arrangement of the treadles, a twilled or dotted appearance is at other times given to them. Venetians are generally used for staircase carpets, but the plaid kind are occasionally used for rooms. Although dots, waves, small figures, and plaids, are sometimes introduced, the general character of Venetian carpets is a simple stripe throughout. They do not come under the head of figured weaving, no machinery but that of the common loom being required for their manufacture. Woollen, linen, and cotton are all used for the shoot.

Kidderminster or *Scotch carpets*, or, as the Americans more descriptively term them, *in-grain carpets*, are wholly of worsted or woollen; or, as is most common, the chain is of worsted and the shoot of wool. The pattern is formed by the intersection of two or more cloths of different colours; but as these cloths may be woven in stripes of different shades by introducing at intervals shoot of different colours, the carpet is usually made to assume a great variety of colours. Wherever this is the case, however, either the upper or under surface must necessarily have a stripy appearance, and the stripes will be seen running across the carpet. The process of weaving these is somewhat complicated, but we will endeavour to give some idea of its nature, and in our description we will confine ourselves to those in which there are only two cloths. These in fact form nineteen-twentieths of the whole quantity. A few, called three-plies, are made with three cloths, for the North American market; and even four-plies have been attempted. Each cloth is perfect in itself, so that if one cloth were carefully cut away the other would remain perfect, and be in appearance like a very coarse baize. The process of weaving both cloths is carried on at the same time, and in each part of the carpet that cloth is brought to the surface which is required to produce that portion of the pattern. We will suppose the two colours to be blue and white, and that the weaver in proceeding with his work is about to throw in the blue shoot. As in common weaving, he must raise by his treadles and gearing one-half of the blue warp to form the cloth; but he must also raise the whole of the white warp in those portions of the carpet where the pattern requires that the upper surface shall be white; this has to be done by

other machinery, as the quantity so to be raised varies with every shoot. After throwing in the blue shoot he has to prepare for the white one, and it is now necessary for him not only to raise, by the treadles, &c., one half of the white warp, but also by the machinery, the whole of the blue warp, where blue is to form the upper surface. He next proceeds to throw the second blue shoot, and has to raise the other half of the blue warp (that which was raised before being now depressed), and also that part of the white warp which this next portion of the pattern requires for the upper surface. The second blue shoot having been thrown, he proceeds to the second white, and raises the reverse half of the white warp and the whole of the blue warp, where blue is to form the surface; and so on as before. The reader will readily perceive that the back of the carpet will necessarily be of exactly the same pattern as the front, but the colours will be reversed; what is blue on the upper surface will be white on the under, and that which is white above will be blue below. Till about forty years ago, the machinery used to manufacture these carpets was of the most clumsy and complicated nature. A great improvement took place afterwards by the introduction of barrel looms, which were constructed on principles similar to those of the barrel organ or musical box. Each pattern, however, required a change in the barrel, and this process was somewhat tedious and expensive. These looms were therefore shortly superseded by the Jacquard machine, which has brought about a vast improvement in many respects, and enabled the largest and most complicated patterns to be accomplished with the greatest facility, accuracy, and beauty.

British or *damask Venetian* partake both of the character of Venetian and Kidderminster, though more of the former than the latter. The warp, as in Venetian, is the only part seen, whereas in Kidderminsters the shoot forms by far the greatest portion of what is visible. The consumption of British is however small, and perhaps hardly of sufficient importance to render a particular description necessary. The manufacture require machinery similar to that employed in weaving Kidderminsters.

Brussels carpets form by far the most important and increasing portion of the carpet trade. Brussels are composed of linen and worsted, the cloth or reticulated part of the structure being entirely of linen, which is formed into a kind of very coarse sampled cloth, with two threads of linen for the shoot (one above, and the other below the worsted). This will be best explained by a simple diagram of a section of the linen only, the worsted not being shown in this sketch. The



dots represent a transverse section of the shoot; the lines crossing one another are two threads of the warp. Now the worsted is firmly bound in between the upper and under shoot, or, as in this sketch, between the two rows of dots, thus; the dotted lines represent three

ends of the worsted, of which there are usually five, each end differing from the others in colour. These ends, as they are technically termed, are composed of one, two, or three threads of worsted, according to the quality of the carpet: the average number is two. Taking it therefore at two, there will always be ten threads, two each of five colours, bound in between every reticulation of the linen. This gives substance, firmness, and solidity to the mass. A pattern or device is thus produced. We have seen that we have five ends of yarn, each of a different colour, at our disposal in every part of the carpet. All we have to do is to bring to the surface that one of the five colours which is required to form that portion of the pattern, and to form it into a loop projecting above the surface. The section then assumes the appearance of the annexed sketch.

This sketch is in fact a section of a bit of Brussels carpet when complete. The business of drawing the required colours to the surface is performed by a child from ten to fifteen years of age, who is called the drawer, and is placed by the side of the loom for this purpose. Each worsted end is made to pass through a small brass eye, called a mail, to which is attached a very fine cord. This cord passes over a pulley fixed at some height above the loom, and is brought down again by the side of the loom, and fixed to a thick stick or roll near to the ground. Now there are generally 260 ends of each colour in 27 inches, the usual width of the carpet; and with five colours in each place we have 1300 ends: there must therefore be 1300 brass eyes or mails, 1300 cords, and 1300 pulleys to each loom. Such is the usual arrangement; but in some instances two cords attached to different mails are united before they reach the pulley, so that there are 650 pulleys and 650 cords passing over them. The pulleys are arranged with great accuracy and neatness in a frame, technically termed the box, which is placed at a considerable height above the mails. The cords being so numerous present a confused appearance to the spectator; but every one has its proper place, and can, when required, be readily traced by the weaver. Now by pulling the cords

as they hang by the side of the loom, it is evident we shall raise the brass eyes connected with them, and also the worsted ends passing through those eyes; and all that is to be done is to pull such 260 of those cords as will raise the colours required, one end in each place. To accomplish this, a strong thread is made to twine around the cords, and separate those which are required to bring the proper colours to the surface. This thread is called the lash, and one lash is necessary for every set or row of colours that has to be drawn to the surface. These lashes are taken in regular succession till the pattern is complete. The number of lashes must therefore vary with the length of the pattern; in a pattern a yard long there are usually 320 lashes. Such being the arrangement of the mechanism, let us suppose the loom at work, and every thing ready for proceeding. The drawer takes hold of the first lash with his right hand, and gently draws towards him the 260 cords confined by it: this separates them from the others, and he then firmly grasps them with his left hand, and having loosed the lash, he with both hands and the weight of his body draws the cords down. The 260 ends required for the first portion of the pattern being thus raised above the surface, he with his left hand inserts (under the raised ends through the whole width of the carpet) a light wooden board called the sword. The sword is about five inches in width, and being made to stand on its edge, it retains the raised ends about five inches above the surface. The drawer then looses the cords, and prepares for the next lash. When the sword is in, and the required colours thus raised, the weaver using both hands carefully raises any of the ends which stick down by reason of the roughness of the material or otherwise; and having thus formed a clear opening, he inserts the wire under the raised ends throughout the whole width of the carpet. The wire is round, and in diameter about the twelfth part of an inch. After the wire is inserted the sword is withdrawn, and the weaver by means of his treadles and gearing brings above the surface one-half of the linen chain, the other half and the whole of the worsted being depressed. The shuttle with linen shoot is then thrown in. The weaver next raises the reverse half of the linen chain, and the whole of the worsted, the half of the chain before raised being now depressed, and then throws in the second or under shoot. Between throwing the first and second shoot, as well as after the second is thrown, the weaver gives two or three smart blows with the lay or batten, which is very heavy; he thus forces the materials closely together, and gives firmness and solidity to the mass. The weaving of this wire is now complete. The drawer then draws the next lash in rotation, and he and the weaver proceed as before. When a number of the wires have been thus woven in, they may be drawn out, and the carpet is complete. Care must however be taken not to draw out the five or six wires that have been woven last, or the fresh made loops are in danger of being drawn down, and the carpet blemished. It is necessary that each end of worsted should work independently of the others; to accomplish this every end is wound on a separate bobbin, and the bobbins are arranged in frames at the back of the loom, with a small leaden weight or bullet to each bobbin to keep the worsted in a proper degree of tension. This adds greatly to the cumbrous nature of a Brussels loom. The linen chains for Brussels and Wilton, as well as the chains for all other descriptions of carpets, are wound on beams as in other kinds of weaving. The Jacquard machine, before referred to, has been constructed so as to take the place of the drawer, pulleys, cords, and lashes; and this machine is found so convenient that it has been brought into general use for that purpose.

Wilton or *pile carpet* differs from Brussels only in this; that the wire, instead of being round, is flattened, and has a groove in the upper surface thus **V**; and, instead of its being drawn out, a sharp knife is drawn along the groove, and the wire is thus liberated. By this means the loops of worsted are all cut through, and the carpet assumes a velvety appearance. The shape of the wire renders it possible to make Wilton or pile carpet of almost any thickness and quality; but this is not the case with Brussels. The manufacture of Brussels carpets was introduced into Wilton soon after its introduction into Kidderminster; the Wilton carpets, being originally a better description of goods were distinguished by the name of cut or Wilton carpets.

In the carpet manufacture, as in most others, novelties of various merit are patented almost every year; but it is unnecessary to notice them in detail. One is for a mode of making Brussels and cut-pile carpets with thick backs, by employing one or more additional sets of weft-threads, tied in by an equal number of warps. Another is for a mode of producing printed warps showing defined figures, by the employment of flat or oval wires. A third is for a kind of carpet made of parti-coloured warps, by applying thick weft to produce two similar corded surfaces, showing the same pattern on both sides of the carpet. Another is for using jute or jute-hemp, instead of common hemp; by a series of boiling, washing, preparing, and spinning processes. At Glasgow, a beautiful kind of carpet is made, as soft as velvet, by throwing in coloured chenille as a shoot, and cutting it into a velvety pile at the surface. One patented kind of carpet, of the velvet texture, is produced thus: In the ordinary mode of making velvet [VELVET], wires are inserted at intervals to assist in forming the loops, and these wires have to be inserted and removed by hand; but in the carpets now under notice, wires are thrown in among the warp-threads, and

removed when the weft is formed, by ingenious mechanism attached to the loom. We have adverted to the attempts made to dye or print carpets in the loom. One such is practised under a patent obtained a few years ago, in order to produce differently-coloured spots, squares, or stripes, by processes independent of the weaving. The warp-threads are arranged side by side in a peculiar frame, so as to form an even horizontal layer; and in that state they are drawn tightly over a printing table, and printed in colours in the usual way. When these threads are applied to weaving, a pattern is produced by a variation of the colours in each thread, in addition to the primary pattern which results from the weaving process.

The power-loom is now largely employed in the carpet manufacture. Mr. Crossley, chief partner of the eminent firm before mentioned, communicated a few important facts on this subject to the Society of Arts in 1856, tending to show that machinery does not always produce the disastrous effects on wages which workmen are so prone to apprehend: "When the Great Exhibition opened in 1851, Messrs. Crossley had no power-looms at work for the carpet-manufacture; they paid 14½*d.* a yard for weaving velvet carpetting by hand. When they introduced the power-loom, they paid 2½*d.* a yard for weaving the same goods: it being done, too, much better than when 14½*d.* was paid. The reduction in price [wages per pieee?] was enormous; and yet at this reduction the weavers earned, on an average, twelve per cent. more by power than they had by hand, for the same number of hours' work. A reduction was made in the [price of the] goods in proportion to the saving effected in the weaving; and he (Mr. Crossley) would undertake to say that no one of the men now at work at power-loom weaving would accept hand-loom weaving at 14½*d.* if it were offered to them, unless their power-looms were taken from them. During the year 1851, Messrs. Crossley paid for wages on an average 150*l.* a day, or 900*l.* per week; but during the year 1855, they paid on the average 250*l.* a day, or 1500*l.* per week." These comparative figures may, however, relate simply to the extension of business, and not to any higher wages earned per man.

We may briefly notice an apparatus patented for cleansing carpets. The carpet is coiled on a horizontal roller, from which it travels to another roller, by means of a web to which it is attached by metal eyelet holes. A number of beaters or flails are affixed to the surface of a large cylinder above the carpet; by means of tappets, catches, excentrics, and springs, the beaters are made to give a succession of smart blows: the carpet progressing, and the cylinder revolving. Further on are two small cylinders, provided with radial brushes, which brush both sides of the carpet as it passes between them. A crank handle turns the whole mechanism. If the carpet require more cleaning than beating and brushing can give it, it passes over a cylinder heated within, and is rubbed by a brush moistened with scouring liquids.

There are no data from which the extent of the carpet manufactured may be determined. It was supposed by persons engaged in the manufacture, about the year 1835, that the carpet-looms in Great Britain amounted to about 4000; and that the value of carpets made in the year was about one million sterling. In the Board of Trade returns, carpets are combined in the same entry with blankets, flannels, and "mixed woollen stuffs," in such a manner that the amount of the exportation of carpets alone is not shown.

The carpet-weavers have made a laudable attempt to introduce the system of arbitration between masters and men, in the event of trade disputes. To lessen the loss and annoyance of strikes and combinations, several of the masters signed a bond of union, binding themselves to observe an equalisation of wages, and agreeing that no one of them should be allowed to reduce below a certain tariff without the consent of all. The workmen feared at first that this was a masters' combination against them; but gradually a better feeling sprang up. Nearly thirty firms, and more than two thousand workmen, had joined this conciliation-parliament (as it was sometimes called) by the year 1855, chiefly confined to the counties of York and Durham. The masters used to hold a meeting annually, to agree about wages and prices; the workmen were informed of the date and place of meeting; they elected delegates from the several carpet-factories; the masters and the delegates sat in different rooms; each body, or "house," presided over by a chairman, deliberated on the state and prospects of the trade; and the two chairmen were made the means of communication when any propositions were to be made on either side. When Lancashire was agitated by the Preston strike, in 1854, Mr. Henderson, an extensive carpet manufacturer at Durham, wrote a letter in which he showed the effects of arbitration in bringing harmony into the carpet trade, and advocated the policy of a similar proceeding in the cotton manufacture: "Before 1839, victory went at one time with the masters, and at another time with the men. Feelings of injury and mistrust prevailed; and in some instances the struggle became so violent, that the masters had to apply to the police for protection of their lives and properties, both by day and night. I have heard the late Mr. Howard of Leeds, and other large manufacturers, say, that the struggle with their workmen had cost them everything but their lives." Then, of the altered state of things produced by the 'carpet-parliament,' he said, "For the last fifteen years the delegates have only once retired with dissatisfaction, and upon that occasion they prayed the masters to reconsider their verdict; the masters immediately held another meeting, and arranged the disputed point to the satisfaction of both parties. Since 1839, five strikes have occurred in distant districts; in each of these cases, the masters of the north of England succeeded in effecting a settlement; and while they have obtained the friendship of those distant masters, they have repeatedly received the thanks of the men." The members of the 'lower house' of this curious parliament, the workmen, themselves sent a letter to the Lancashire cotton-spinners during the Preston strike, describing the benefit which had accrued to the carpet-trade, and suggesting conciliation instead of hostility as the best strategy in the cotton-trade also.

CARPOBA'LSAMUM, a kind of volatile aromatic oil, said by Bruce to be furnished by the *Balsamodendron Gileadense*. It is produced by the nuts, which have a fleshy kernel yielding the balsam by simple expression. It should be employed while recent, otherwise it loses its odour and becomes inert.

CARRAGEENIN. Irish moss (*Chondrus crispus*), contains a kind of vegetable jelly or pectin, which is thought to be peculiar, and to which the name carrageenin has been given. It is distinguished from gum by its aqueous solution not being precipitated by alcohol, from starch by giving no blue colour with iodine, from animal jelly by giving no precipitate with tincture of galls, and from pectin by not being precipitated with acetate of lead. Herberger found Irish moss to contain the following ingredients:—

Carrageenin	79·1
Mucus	9·5
Two resins	·7
Fatty matter and free acids Chlorides of sodium and calcium Sulphate of potash Iodine or bromine	traces.
Water and loss	10·7
	100·0

CARRIAGE. [Stage Carriage.]

CARRIER is one who undertakes for hire the conveyance of goods or passengers for any one who employs him. But a mere carrier of *passengers* is not a *common* carrier according to the legal meaning of that term,—this term comprehending those only who convey *goods*, either by land or water; as, for example, mail contractors; the proprietors of a common stage coach or waggon; the owner or master of a general ship; or a wharfinger who undertakes to convey goods from his wharf in his own lighters. So a railway company are common carriers. And a carrier is held to be a common carrier, and liable as such, although one of the *termini* of his journey be out of England.

I. *The liability and duties of carriers, as regards the conveyance of passengers.*

By the common law, a carrier of passengers is bound to take care that his carriages and engines, or his coach, harness, and horses are *roadworthy*, that is, sufficiently secure to perform the journey he undertakes; and he will be liable to make compensation to any passenger who is injured in consequence of any insufficiency in this respect. And the fact of an accident happening to a passenger while the carriage in which he was being conveyed, was exclusively under the management of the carrier or his servants, is *primâ facie*, sufficient to entitle him to claim compensation against the carrier; so that the burden of proof is thrown upon him to show, that the injury was the result of an *inevitable* accident, and that the goodness of the vehicle and the skill and care of his servants were unimpeachable.

But if the passenger be injured by reason of an accident which was *inevitable*, the carrier will not be liable. For a carrier of passengers does not *warrant* their safe conveyance; but merely undertakes that, as far as human care and foresight can go, he will provide for the same.

II. *The liability of carriers as regards the conveyance of goods.*—Carriers of goods are subjected to a greater degree of responsibility than mere bailees for hire [Bailment], and that responsibility is much more extensive than it is in the case of carriers of passengers. By the ancient custom of the realm (which is part of the common law), a common carrier of goods for hire is, in general, not only bound to receive goods tendered to him for carriage, if he have room in his conveyance; but he absolutely insures their safety, against *inevitable accident*; and he is therefore liable for their loss, though he be robbed of them by a force which he could not resist. There are, however, by the common law, three exceptions to this extensive liability: 1st, loss arising from the aggression of the Queen's enemies; 2nd, loss arising from the act of God, such as storm, lightning, or tempest; and 3rd, loss arising from the owner's own fault, for example, by imperfect packing. So a common carrier may limit his responsibility by entering into a special contract with his customer. But in the case of a railway or canal company, the customer will not be bound by any condition or contract which is not in law just and reasonable; and which is not evidenced by being signed by the customer, or by the person who delivers the goods for carriage. (17 & 18 Vic. c. 31, s. 7.)

Formerly, where there was no special contract with the customer, it was the practice of carriers to endeavour, by means of notices, to lessen the extensive liability which the common law cast upon them. The notices they were in the habit of giving usually stated, in substance,

that the carrier would not be responsible for goods above a certain value (generally 5*l.*), unless entered and paid for accordingly. After repeated discussions on the effect of these notices in courts of justice, the carriers succeeded in establishing, that they would not be liable in the above circumstances, if they could *prove* explicitly, in each instance, full knowledge on the part of the person sending the goods, or his agent, of this specific qualification of their general liability. But proof of this fact was in all cases most difficult to adduce; and, to obviate this hardship, the "Carriers Act," 11 Geo. IV., and 1 Will. IV., c. 68, was passed, by which it is enacted that no common carrier by *land* shall be liable for the loss of, or injury to, certain articles, particularly enumerated in the Act, contained in any package which shall have been delivered, either to be carried for hire, or to accompany a passenger, when the value of such article shall exceed the sum of 10*l.*, unless, at the time of the delivery of the package to the carrier, the value and nature of such article shall have been explicitly declared. In such case the carrier may demand an increased rate of charge, a table of which increased rates must be affixed in legible characters in some public and conspicuous part of the receiving office; and all persons sending goods are bound by a notice thus affixed, without further proof of the same having come to their knowledge.

And by the 17 & 18 Vic. c. 31, s. 7, railway and canal companies have been further exempted from liability beyond a limited amount, for damage sustained by horses, cattle, and other animals whilst being carried by them, unless their value be declared at the time they are delivered to the company, and an extra payment made in order to cover the increased risk.

By sec. 3, of the same statute, railway and canal companies are bound to afford all reasonable facilities for receiving, forwarding, and delivering their traffic, without giving any undue or unreasonable preference or advantage in favour of any particular person or kind of traffic, or subjecting any such person or kind of traffic, to any undue or unreasonable prejudice or disadvantage. And by sec. 3, power is given to any one who complains of a breach of the above obligations, to obtain redress by motion in the court of Common Pleas in *England*, or in one of the superior courts in *Dublin*, or, in the Court of Session in *Scotland*.

The liability of carriers *by sea* is modified by the statute 17 & 18 Vic. c. 104, ss. 502—506, whereby the liability of owners of vessels for any damage or loss caused to any goods or merchandise on board the same without the actual fault or privity of the owner, is limited to the value of the vessel and freight. They are also exempted from loss or damage by fire, and from the loss of, or damage to, gold, silver, diamonds, watches, jewels, or precious stones, by reason of their being robbed, secreted, or embezzled, unless the shipper of the goods insert in his bill of lading, or otherwise declare in writing to the master or owner of the vessel, the nature, quality, and value of such articles respectively.

Subject to these exceptions, and to any special contract that may have been made by bill of lading or otherwise, a carrier by sea is liable for all losses, except those occasioned by the act of God, or the queen's enemies; or by the default of the shipper of the goods. And if the ship deviate unnecessarily from her direct course, and the goods are lost or damaged during such deviation, the ship-owner will be liable, even although the loss be occasioned by the act of God or the queen's enemies.

Lien of Carriers.—Upon the general principle, that persons who, at the request of their owners, bestow money or labour on goods, can detain them until their charges in respect thereof are paid, a carrier has a right to detain goods, which have come into his possession *as a carrier*, until his reasonable charges for the carriage are paid. This in law is called a *particular lien*, in contradiction to a *general lien*, which is the right of retaining goods for the balance of a general account.

(Sir W. Jones on *Bailments;* Selwyn's *Nisi Prius*, title *Carrier;* and Chitty on *Contracts* (by Russell), title *Carrier*.)

CARRONADES are short iron guns, differing from other guns, and from howitzers, only in their dimensions, and in the manner of attaching them to their carriages; which is by a loop underneath, through which a bolt passes, instead of trunnions. They derive their name from the village of Carron, in Stirlingshire, where they were first made.

When fired at point blank, their range is about 150 yards; and, at an elevation of 3 degrees, it varies from 660 to 750 yards; this is much inferior to the range of a long gun, but as they throw shells and heavy shot with great effect within the above limits, they are extremely serviceable on land for breaching ramparts of earth, or for enfilading the faces of works; and at sea, in engagements at close quarters. A flash-rim or enlargement of the bore takes the place of the enlargement of the muzzle, in order to protect the sides and rigging of the ship from the effects of the explosion, and to facilitate the charging.

For the dimensions and weights of carronades, see Spearman's 'British Gunner.'

CARROT (in horticulture), the fleshy root of the *Daucus carota*. This kind of esculent is too well known to require any description. For garden purposes there are three principal varieties; namely, the early horn carrot, a small kind used for the earliest crops; the long orange, or Altringham carrot, a very large kind, for ordinary summer and winter use; and the purple carrot, a French sort, remarkable for its deep purple colour and unusual sweetness. The latter is not so much known as it deserves to be; the two others are in common use. Several others, among which is a white kind, are mentioned in seedsmen's lists, but they are of little importance.

Nothing can be easier of cultivation than the carrot, provided the soil is light and free from stones; in stiff or rocky soils it is not worth the expense of growing. The seeds are sown at intervals, from the end of February till the beginning of August; they are lightly raked into the soil, having been previously pressed down with the feet. Some persons mix them with damp sand previously to sowing, in order to separate them from each other, and to render them less liable to be blown about by the wind in consequence of their lightness. When they have come up they require no further care than to be hoed to the distance of about six inches apart, and to be kept free from weeds.

CARROT (in agriculture). The large orange carrots, which are the most common for winter provision, are chiefly raised in the fields; and when they can be conveyed to large towns for sale, they are a very profitable crop on light and deep soils. The principal use of the larger field-carrots is as food for cattle. The orange carrot and its varieties are the most common in England, but the large white and yellow carrots, most esteemed on the continent, are now largely cultivated here; though containing probably less saccharine matter, their produce is so much larger that they produce a greater bulk of nutriment on the same ground. The white carrot also will grow on heavier soils than the orange. It is, in Belgium, sown in spring amongst barley, in the same manner as clover usually is; with this difference, that the roots are taken up before winter, and the land may be sown with winter corn the same year. The barley amongst which the white carrots are sown is chiefly winter barley, which is reaped early. As soon as the barley is cut, the land is well harrowed to pull up the stubble, the weeds are carefully taken out, and liquid manure is poured abundantly over the surface. The carrots, which were scarcely visible, and of which the tops were cut off in reaping the barley, now shoot rapidly, and where they grow too thick are thinned out by hoeing. By the end of autumn a good crop of carrots is obtained; and if they are carefully forked up, the ground may be sown with rye without any other preparation. This, however, is not at all to be recommended as an English practice.

When carrots are cultivated in a regular rotation as a principal crop, they are sown in March, or early in April, on land which has been ploughed to a considerable depth before winter, and has had the benefit of the winter's frost. It is not usual to manure the land, but it is best to sow carrots on land which has been abundantly manured either for the preceding crop, or early in the previous autumn. If it be thought necessary to improve the land by manure, it must be done with well-rotted dung, which should be ploughed in very deep. Without this precaution the carrots will be apt to *fork*, as it is called; the root being divided will not swell regularly, and instead of being of a fleshy consistence will become fibrous and hard. The best mode of cultivation is to have the land in a moderately rich state and thoroughly pulverised; to sow the seed in drills, at the distance of a foot or more from row to row: to cover it slightly; and as the plants appear, to water them with diluted urine or the drainings of dunghills; to destroy all weeds carefully by the hand and the hoe, and to thin the plants in the rows to the distance of 5 or 6 inches or more, according to the richness and depth of the soil. Although the carrot, when it grows most vigorously, does not throw out any considerable fibres from the upper part of the root, and appears to draw its chief nourishment from its lower end, yet it is a great advantage to keep the ground stirred and light between the rows; for exceedingly minute horizontal fibres shoot out to a considerable distance from the sides of the root, and tend much to increase its size. The seed of the carrot has numerous hooked hairs which spring from the husk, and make the seeds adhere together; on this account carrot seed is usually mixed with earth or sand, and well rubbed in the hand before it is sown. Five or six pounds of seed are needed for an acre if the seed is drilled; it requires more than this if sown broad-cast. In this last way very heavy crops are sometimes obtained, but the expense of weeding the carrots by hand is so great that the drilled crops, besides being more certain, are more profitable. Too much care cannot be taken in selecting good seed. The finest and largest carrots should alone be chosen to plant out in spring to produce seed. They will throw out vigorous stems bearing numerous umbels, which, as the florets fade and the seeds ripen, contract into the form of a bird's nest. Those who are curious in the choice of the seed take only such seeds as grow on the outer border of the umbel. The tops of the carrots are frequently cut off before they arrive at the full size, as food for cattle and sheep, who are very fond of it; but this is not a judicious plan; as the loss in the growth of the roots from being deprived of the leaves is much greater than the value of the tops as food, especially if they are cut off repeatedly, which is sometimes done when fodder is scarce. When the plants begin to wither, and the outer leaves to droop to the ground, the tops may be safely mown, and the roots left in the ground. They have then acquired their full growth, and will remain sound in the earth till there is danger from the winter's frost.

The best method of taking up the carrots to store them for winter use is by means of three-pronged forks, such as are used in digging asparagus beds. They should be rather blunt at the point and sides

of the prongs, and be stuck into the ground vertically by the side of the rows; by pressing down the handle the carrots come up without injury. It costs 18*s.* to 20*s.* per acre to dig up a good crop. The plough is sometimes used after the coulter has been removed; but with all the care of the ploughman, the plough and the horses will cut and bruise many of the finest carrots. Carrots may be kept all winter in dry cellars, if they are protected against the frost. The more common way is to store them with straw in long trenches, like beet. [BEET.] The produce of cattle-carrots on good light land may be 10 to 15 tons per acre, and they do not impoverish the land so much as potatoes. From twenty to forty pounds of carrots, with oats, is a sufficient allowance for a hard-working horse for twenty-four hours. Where hay is scarce, it is a most economical substitute.

In Brittany they have an ingenious method of getting several acres of land trenched by the plough and the spade at the same time, for the growth of parsnips and carrots. The different farmers join to bring as many labourers together as will dig out a furrow as rapidly as the plough can draw it: they divide the whole length of the field equally among them. As soon as the plough has made a furrow, the men trench the bottom of it with their spades nine or ten inches deep, throwing the earth over the furrow slice last turned; on the return of the plough the next slice is turned into the deep trench and immediately covered by the spades as before. Thus an acre is readily trenched in one day to the depth of fifteen or eighteen inches, and all the weeds are buried: carrot or parsnip seed is sown on the surface and slightly harrowed in. The common mode of ploughing in stitches is the most convenient for this operation, as each man will only have to move from one side of the stitch to the other immediately after the plough has passed. But a second plough following in the furrow made by the first will do the work equally well, and at less expense.

If carrots are cut in pieces and steamed, they become more nutritious, and the expressed juice made to ferment affords by distillation a very good and wholesome spirit. Sugar may also be extracted; but the carrot is inferior to the beet in this respect.

CARTE-BLANCHE (literally, white card) is a paper signed, and, if necessary, sealed by the party against whom it is to be used, but (with the exception of the signature and seal) blank; in order that it may be filled up with such conditions as the party to whom it is delivered may prescribe. Thus, when Charles I. was about to be condemned, his son, Prince Charles, sent to the Parliament a blank paper signed and sealed by himself, in order that they might dictate their own terms for saving his father's life.

The term is often used to express an unrestricted authority delegated by one man to another; thus a general is said to have carte-blanche from his sovereign when he has leave to carry on the war at his own discretion.

CARTHAMIN ($C_{28}H_{16}O_{14}$). The florets of the *safflower*, or *Carthamus tinctorius*, a plant of the natural order *Compositæ*, contain two colouring matters: one, extracted by water, is yellow, and quite unimportant; the other, insoluble in water, is red, and is called *carthamin*, or *carthamic acid*. It is best obtained pure by first washing the florets in weak vinegar, to extract the yellow colouring matter, and then digesting them in a dilute solution of carbonate of soda, which dissolves out the carthamin. From this solution it may be precipitated on flocks of cotton wool, placed for that purpose in the liquid, by acetic acid or lemon-juice. From these, after washing, it may be obtained by re-digestion in dilute carbonate of soda solution, and re-precipitation by acid. Washed and dried, it presents the appearance of a brilliant green amorphous powder, of metallic lustre. In thin layers, by transmitted light, it appears a rich red-purple. When moist, it browns turmeric paper. It is insoluble in water or acids, slightly so in ether, and more so in alcohol, yielding a beautiful purple liquid. It is very soluble in alkalies.

Safflower is largely used as a dye, on account of the carthamin it contains. The colour is very beautiful, but fugitive.

Pink saucers, sold at colour-shops, for dyeing silk, &c., are prepared with carthamin.

Vegetable rouge is usually carthamin mixed with powdered French chalk.

Chinese card rouge is a small folded card, apparently covered with carthamate of soda, colourless at first, but, rubbed on the skin, is then decomposed by the acid secretions, producing a beautiful rosy tint.

CARTHUSIANS. The Carthusian monks were a branch of the Benedictines, whose rule, with the addition of a great many austerities, they followed. Bruno, who was born at Cologne in Germany, first instituted the order at Chartreux, in the diocese of Grenoble in France, about A.D. 1080; whence the monasteries of the Order, instead of Chartreux-houses, were in England corruptly called *Charter-houses*. The rule of the Carthusians, which is said to have been confirmed by Pope Alexander III. as early as 1174, was the most strict of any of the religious orders, the monks never eating flesh, and being obliged to fast on bread, water, and salt one day in every week: nor were they permitted to go out of the bounds of their monasteries, except their priors and procurators, or proctors, and they only upon the necessary affairs of the respective house.

The Carthusians were brought into England in 1180 or 1181, by King Henry II., almost as early as their establishment at Grenoble, and had their first house at Witham, in Somersetshire. [BENEDICTINES.]

CARTOON, from *carta*, paper, *cartone*, large paper, Ital.; a word used by artists to signify the full-sized drawings or studies made in chalks, or in body-colour (*tempera*, as it is called in Italy), preparatory to executing any great work either in oil-colour or fresco. Cartoons are also made when the design is to be copied in tapestry.

The preparation for making cartoons is very simple: Several sheets of paper are pasted together at the edges, and then strained on a frame of the size required. Sometimes the surface is *primed*; that is, washed with a general colour or ground, but more frequently the paper is left in its natural state, and the drawing is made either in chalks or, as above stated, in *distemper*. When only two colours are used, as black and white, or brown and white, it is called "in chiaroscuro," that is, light and shade. The cartoon being finished, it is transferred either by laying it upon the canvas on which the picture is to be painted, and tracing the lines through with a hard point (powdered charcoal, or black lead, or chalk, being first rubbed on the back of it, or on paper placed between it and the canvas); or lines are drawn over it perpendicularly and horizontally at equal distances, and exactly corresponding lines or squares being made on the canvas, the parts of the cartoon are carefully copied into them, and the colouring is then commenced. The injury which the drawing of lines over it might do to the cartoon may be avoided by straining threads across it from pins at the required distances round the frame. In *fresco* painting the plaster on which the work is to executed must be wet, and only a small portion can therefore be completed at a time; the transfer of the cartoon is effected here in small compartments, either by tracing as much as the artist means to finish, or by pricking the lines through.

The great masters seldom commenced any extensive picture without first making studies or cartoons in chiaroscuro. Many of those by Raffaelle, Andrea Mantegna, Domenichino, the Carracci, and others, remain to attest the laborious diligence and care with which their great works were accomplished. By this means the composition, drawing, expression, and light and shade, were all perfected before the colouring of the picture was attempted, and as these may be said to constitute the highest qualities of art, the schools that chiefly attended to them, namely, the Roman, Florentine, and Bolognese, are eminently distinguished for their *grand style*.

The finest specimens of cartoons that are known are those executed by Raffaelle d'Urbino, for Leo X. in 1615-16, and which were sent to Flanders, to be copied in tapestry, in two sets. One was intended for the decoration of the pontifical apartments in the Vatican; the other as a present from the pope to Henry VIII. of England. The tapestries (only shadows of Raffaelle's exquisite designs) were finished (the first set being hung up for the first time in the Sistine Chapel on the 26th of December, 1519), and one set is now in Rome. The other was in England till the death of Charles I., when it was purchased and carried to Spain by the Spanish ambassador. A few years ago this set was purchased from the family of the Duke of Alva, by Mr. Tupper the British consul, who brought them to London and publicly exhibited them; but failing to find a purchaser they were carried back to the Continent, and eventually, at the suggestion of Chevalier Bunsen, purchased for the Berlin Museum.

The cartoons, originally twenty-five in number, were left neglected at the tapestry works at Arras, in the Netherlands, and most of them seem to have been lost or destroyed. A few, however, escaped this fate, and seven are now at Hampton Court. Their history, even since their arrival in England, is eventful. They were bought in Flanders by Rubens for King Charles I., with a view to their serving as patterns for the tapestry works at Mortlake. They were cut in slips and packed away in boxes; but they do not appear to have been removed from Whitehall. At the dispersion and sale of the royal collection the cartoons were secured to the country by purchase, by Cromwell's particular command: at which time, we are told, the triumphs of Julius Cæsar by Andrea Mantegna (still preserved at Hampton Court) were valued at 2000*l.*, while the cartoons of Raffaelle were estimated at only 300*l.* In the reign of Charles II. they were again consigned to neglect. It is indeed said by Richardson, that Charles was only prevented by the representations of the Earl of Danby, from selling them to Louis XIV., who was anxious to purchase them for his tapestry works. Charles II. re-established the works at Mortlake, and the cartoons were sent there, and there were left unregarded. When William III. wished to have them hung up they were found to be seriously injured, but the king directed Henry Cooke, a painter of some reputation in his day, to repair them and to strain them on canvas. William also employed Wren to design a gallery at Hampton Court for their reception, in which they remained till 1764, when George III. removed them to Buckingham Palace; and in 1787 to Windsor Castle. They were, in 1814, again removed to Hampton Court, where they now are.

The cartoons represent the following striking subjects from the New Testament:—

Paul preaching at Athens.
The death of Ananias.
Elymas the sorcerer struck with blindness.
Christ delivering the keys to St. Peter.
The sacrifice at Lystra.

The Apostles healing the sick in the Temple.

The miraculous draught of fishes.

This is not the place to speak at length of the merits of these grand works. It will be enough to say that they are universally admitted to be, as designs, the very finest of Raffaelle's works, and that they rank among the very noblest productions of the painter's art. The compositions are in the highest degree masterly, and the stories intended to be illustrated are told with the greatest perspicuity. In the details they exhibit every variety of character and expression: the mild sublimity of our Saviour, the quiet dignity of the Apostles, admiration, doubt, surprise, pain, fear, down to the careless innocence of childhood, are all portrayed with a master's hand. The women are almost perfect delineations of grand female beauty, and the children, wherever they are introduced, are models of infantine grace and simplicity. In the arrangement of drapery Raffaelle was unrivalled, and the cartoons offer the finest examples of excellence in this respect. These exquisite works can scarcely be too often or too carefully studied by those who desire to form a pure and elevated taste in design.

These cartoons have been engraved by Dorigny, Audran, and Holloway, and in a bold but effective manner (so as to be published at a very moderate price), by John Burnet; but during the summer of 1858 two series of photographs of the cartoons on an unusually large scale, and separate studies of single figures, heads, &c., were made by Messrs. Caldessi and Montecchi, and Mr. Thurston Thomson, which afford copies of the cartoons infinitely preferable to the best engravings for the purpose of study. There are engravings of a greater number of the cartoons than those in the English collection, some of which are taken from the tapestries; of others it is believed the originals no longer exist. Five from tapestries represent the Adoration of the Kings—Christ appearing to Mary Magdalen—the Disciples at Emmaus—the Murder of the Innocents—the Ascension. Others are described by Fea, in his 'Descrizione di Roma,' and Somereau, a French artist, engraved them, with the whole series, in 4to.

Two very fine cartoons in black chalk, by Annibale Carracci, are now in the National Gallery; they were formerly in the collection of the Earl of Ellesmere, who presented them to the nation. They are studies for parts of the decoration of the Farnese Palace in Rome, and offer examples of the free and large style of design which characterised this artist's pencil. Some of the cartoons prepared by English artists for the fresco decorations of the New Palace at Westminster, have been placed in Hampton Court.

CARTRIDGE, a cylindrical case, containing a charge of gunpowder or shot, or of powder and ball, for fire-arms. Those used for military purposes, to facilitate the loading of muskets, carbines, and pistols, are formed of a strong hard paper manufactured for the purpose, called cartridge-paper, and are styled ball or blank cartridges according as they contain both powder and ball or powder only; while the larger cartridges for cannon and mortars, which always consist of powder only, are usually cased with flannel, though sometimes paper, pasteboard, tin, or even wood is employed. The North Americans, during their last war with England, are said to have employed very thin sheets of lead, resembling those used for lining tea-chests, for this purpose. The advantage of such a substance is, that it obviates the danger of burning particles of the cartridge-case which remain in the piece after it is fired,—an accident which is liable to occur when flannel is used, and which may be productive of the most fearful consequences.

Wire cartridges, for containing a charge of small shot without powder, are manufactured for sporting purposes. The author of the article 'Shooting,' in the seventh edition of the 'Encyclopædia Britannica,' states that they were invented in 1828 by Mr. Jenour, but that they were not brought to perfection until nearly ten years later, owing chiefly to the difficulty of regulating the precise time for the dispersion of the shot. Eley's wire cartridges have been brought, by successive improvements, to a high degree of efficiency, and are made of various qualities, according to the distance at which the charge is required to take effect. Wire cartridges consist of an inner case of wire network, inclosed in a thin paper case, to the outer end of which a wadding is attached. The shot, with which it is usual to mix bone-dust or some other substance to fill up the interstices, is put within this case, which is rammed down upon the charge of powder. When the gun is fired, the paper case is torn to pieces as soon as the cartridge leaves the gun, and the shot immediately begins to quit the cartridge by passing through the meshes of the wire net work, which is carried forward with the charge until it is quite empty, when it falls to the ground. By this contrivance the leading of the gun is avoided, and the recoil produced by the discharge is lessened, the charge leaving the barrel like a bullet. The shots are also carried so much more closely than when loose, that lighter charges, and consequently a lighter gun, may be used; much time is saved in loading, especially as no separate wadding is required; and, as the cartridge has no inclination to move before it is impelled by the explosion of the powder, the danger arising from the accidental shifting or rising of loose charges is avoided. Greener, in his work entitled 'The Gun; or, a Treatise on the various descriptions of small Fire-arms,' which was published before wire cartridges had been brought to their present state of comparative perfection, suggests the use of a case of felt, made much thicker at the bottom than at the sides, as a substitute for wire.

In the 'Transactions of the Society of Arts,' vol. xlv. pp. 106, 107, is a description, illustrated by figures, of a machine invented by Mr. Caffin for filling cartridges, in which two cylindrical cases, each of which will contain the proper charge for one cartridge, open at both ends and tapering a little at the lower end, are so mounted that by moving a handle each may be brought alternately under a hopper, from which it receives a supply of powder, and then over an aperture in a plate upon which it moves, through which the charge escapes by a conducting channel into the paper case of the cartridge. With one of these machines one boy is able to deliver 12,500 measures of powder in a day, supplying the hopper himself.

The cartridge employed for the rifles of the present day is made with three pieces of paper: 1st, a stiff paper is rolled round the mandrill, a wooden cylinder of the size of the cartridge; 2nd, an envelope of thin paper is wound round this and folded into the hollow at the end of the mandrill, and pressed in with a "former," which has a conical point of the shape of the bullet; 3rd, the bullet is put with its point into this cavity, and the whole wound round with another layer of thin paper, or outer envelope, and fastened under the bullet. The mandrill being then withdrawn, the powder-case is filled with powder, and the thin outer cases squeezed just above the stiff paper, and the end laid down with a slight twist. The bullet is now covered with only one paper, while the powder has three; the paper over the bullet is lubricated with bees'-wax and tallow, and the cartridge is complete. In using these cartridges, the top being torn off, and the powder poured into the barrel, the cartridge is reversed, and the ball being entered nearly to its head in the barrel, a smart twist tears off the stiff powder-case easily at the place where it joins the thin covering of the bullet, which is then left with its point free, and with a cover of lubricated paper round it. Another method of making cartridges has lately been adopted in the Royal Arsenal at Woolwich; in this process the whole cartridge is made in one bag. A series of hollow mandrills, with small holes all over their surface, are fixed into, and the hollows communicate with, a circular tube, from which the air is exhausted by a steam-engine. Over these mandrills canvas bags are placed, and the circular tube is lowered into a bath of paper pulp, so as just to cover the mandrills which project downwards. The air being then exhausted, the water of the pulp is drawn through the canvas and holes in the mandrill, and leaves a certain amount of pulp adhering to the canvas bag; the part to contain the powder being made thicker by larger holes in the mandrills at that place than where the bullet comes. The circular pipe with the mandrills being then removed, is fixed to a steam pipe, and hot steam passed back through the canvas bags, which drying the pulp, the paper bags are easily removed.

CARTS AND WAGGONS. The drag-cart without wheels, which is used in some mountainous districts, is one of the simplest contrivances for transporting heavy weights. It consists of two strong poles, from twelve to fifteen feet long, connected by cross pieces fixed at right angles to them, by morticing or pinning, so that the poles may be two or three feet apart. About eighteen inches of the poles project beyond the lowest cross piece, the ends resting on the ground. The other ends of the poles form the shafts for the horse to draw by. The load is placed on the cross pieces, over which boards are sometimes nailed, for the purpose of carrying stones, or such things as might fall through between the cross bars: it then resembles the body of a cart taken off the wheels. The horse bears one end of the drag-cart by a strap over his back, and draws it by means of a common cart-collar or breast-strap. This vehicle is extremely useful in steep and rough descents, especially to draw stones from quarries, and can be made of rough poles at little or no expense. Pieces of hard wood fixed under the ends of the poles, and renewed as they wear out, will prevent the ends of the drag-cart from wearing away, and will allow it to slide along more easily.

The Irish car (*fig.* 2) may be considered as the next step towards a better construction. This car consists of a bed or platform and two shafts. The wheels, in the simplest form, are round discs of wood made by nailing planks to a thickness of two or three inches over each other, so that the fibres of the wood in one plank shall lie at right angles to those in the other; they are then sawn into the form of a circle, and an iron tire put on the circumference. Two of these discs are fixed on a square axle of wood at the distance of three or four feet from each other. The ends of the axle, which project three or four inches beyond the wheels, are then rounded in the form of cylinders of two or three inches diameter. To the under part of the bed of the cart two blocks of wood are fixed, which raise it so that the wheels may go under the cart, and in these blocks are two round holes to admit the ends of the axle. Two strong nails or iron pins driven obliquely into the blocks after the wheels are put under, serve to prevent the axle from slipping out. A little grease on the ends of the axle diminishes the friction, and prevents the disagreeable grating of the wood when the wheels turn round. This is the simple old Irish car. The only difference in the construction of the most improved modern cars is the substitution of neat wheels, and iron axles for those described above, and a railing or box fixed on the platform. The great simplicity of the Irish car, its easy construction, and the convenience of the platform to place the load on, are its greatest recommendations. It is well adapted to narrow mountainous roads; and the wheels being quite under the bed, there is less danger when two carts meet,

or among trees and rocks; especially when one man has the charge of several cars, or the horses are permitted to find their way home by their own sagacity. There is a considerable inconvenience in turning, as the wheels do not turn separately, and one of them must be dragged

Fig 1.

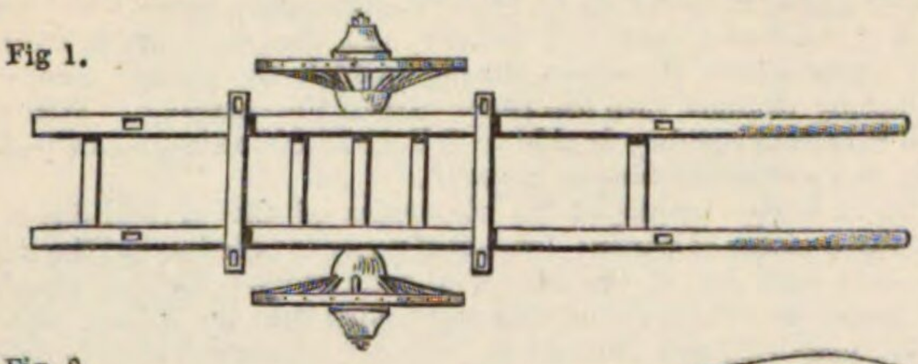


Fig. 2.

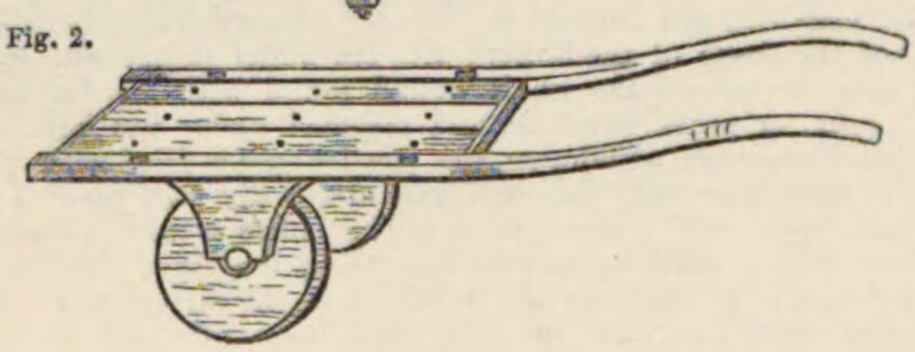
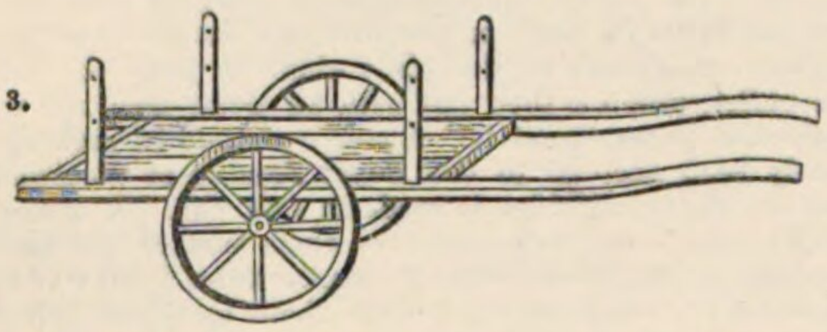


Fig. 3.



along, while the other forms the centre round which the car turns. This description relates wholly to the agricultural and quarry and general goods cars. In the improved passenger or *jaunting* cars, the wheels are made to turn separately on the axles, by which this inconvenience is obviated. The wheels of the carriages on railroads are constructed on the principle of those of the Irish car. The axle turns with the wheels in a bush or box fixed to the carriage. This gives greater facility for keeping a constant supply of oil to the box by means of a fixed reservoir; and the carriage not being required to turn round, no inconvenience arises. Some of the remarkable circumstances connected with the establishment of Mr. Bianconi's car traffic in Ireland will be found noticed under STAGE CARRIAGE.

The common cart differs from the car chiefly in the circumstance that the body rests on a fixed axle between the wheels, which turn upon the axle by means of boxes in the centre of the naves. The simplest cart is that used by carriers in France and Germany. (*Figs.* 1 and 3.) It consists of two strong poles of ash or beech, resembling those of the drag-cart described above, but stronger, and fashioned with more care, so as to have considerable strength at the place where they rest on the axle-tree. One end forms the shafts, and the whole is equally poised on the axle. The wheels are often nearly six feet in diameter, and narrow at the tire; they are slightly dished, but run nearly perpendicularly to the road. On these carts very great weights are transported, so as to require five or six horses to draw them. On paved roads they may have some advantages; but there is much loss of power when many horses draw at length; and the horse in the shafts is often much distressed by the weight suddenly thrown on his back, and by the striking of the shafts against his sides. It would be impossible for the shaft-horse to bear the weight in going down steep descents, or to keep his footing up steep hills (however well the cart may be poised), if it were not for an ingenious contrivance, by which the load is shifted at pleasure backwards or forwards on the axle. In ascending, the centre of gravity is moved nearer to the horse, and, in descending, farther back, so as to be always nearly perpendicularly over the axle. Another contrivance is a mode of retarding the motion of the wheels in descending. This is done by forcing a pole against the outer rim of the wheel, one end being fixed to the shafts of the cart, and the other drawn, by means of a rope, tightly against the side of the wheel, which rubs hard against it. The object is thus obtained; but the wheels are soon worn away, and the pole requires to be carefully looked to, because it often wears through and breaks, when the whole load comes suddenly against the horse and throws him down. Another equally rude and extremely noisy mode is to cut a tough branch, a little longer than the distance between the wheels, and place it horizontally between the spokes, so that it projects about an inch or two on each side. The wheel, in turning round, bends the branch until the ends escape from one spoke and strike the next; thus a constant retardation of the wheel takes place at the expense of the spokes, which are soon worn out. A better contrivance is a piece of wood or iron in the form of a small segment of a circle, of the same diameter as that of the wheel, which is made to press more or less on the rim of the wheels by means of a lever to which it is attached. It is regulated by a

screw turned by a winch, which gives the exact pressure requisite to overcome the downward tendency of the load, and may be so nicely adjusted that it requires only a slight exertion in the horse to draw the cart down. By some of these contrivances many of the inconveniences arising from the use of carts are obviated. Where the roads are level and hard, waggons are much to be preferred to carts; but in hilly countries and bad roads, carts have many advantages.

For agricultural purposes, various kinds of carts have been invented. The capacious tumbril for carting earth and dung, with broad wheels to prevent their sinking in soft ground, is too generally known to require description. The best constructed carts have iron axles with the ends or arms turned smooth, and very slightly conical. The boxes in the naves of the wheels, which receive the arms, are made of cast iron, and ground smooth, so as to require only a small quantity of grease or oil to make the wheels run easily, without allowing any play or side motion. It is usual to give the axle a bend at the place where it enters the wheel, by which means the planes of the wheels are made to diverge from each other and give more room for the body of the cart. But this is decidedly wrong. It is clearly proved that the draught is least when the arms are quite horizontal, and if the wheels are slightly dished, that is, if the spokes are driven into the nave obliquely so as to throw the rim a little beyond the perpendicular, the lower spokes in each wheel will slightly diverge, and give greater steadiness to the whole. When the axle is bent, the rim of a broad-wheeled cart must be slightly conical, in order that it may rest flat on the ground; and it is easily proved that in this case the load is dragged on the ground at every revolution, along a space equal to the difference between the greater and lesser circumference of the rim of the wheel, giving unnecessary work to the horses, and greatly injuring the roads. The light Scotch cart, drawn by one horse, is justly considered as the most advantageous for transporting earth, lime, or dung, especially in hilly countries. It is low and short, so that the horse draws very near the centre of gravity; and there is little power lost by obliquity. The loads may be so adjusted as to bear more or less on the horse, according to the declivity; and experience has proved that more weight can be transported by a given number of horses, when each is attached to a single Scotch cart, than when three or four draw together, except it be on very level and hard roads, or when the horses move at a quick pace. The objection made to single-horse carts, that each requires a man to drive it, is obviated in Scotland, where the horses are trained to follow each other, and one man can attend to several carts and horses. In England this is not allowed on the roads for fear of accidents.

The Scotch cart is made to carry hay and straw by means of a light frame, which is laid on it, and projects over the body and the wheels in every direction. At harvest it is found that this arrangement enables the farmer to collect the sheaves of corn and carry them to the stack or barn more rapidly than could be done by a waggon. A good horse will walk faster, when he has a load on his back, than he could do if he were merely drawing; and although this exertion, if continued long, would exhaust him, he soon recovers his breath, if he has only been urged for a short distance, and then returns with a light empty cart.

To avoid the weight resting on the back of the horse, carts have been invented with three wheels, the small additional wheel being made to turn in front. It is only in the case of moving earth down a declivity, and returning with the empty cart, that it has any advantage over the two-wheeled cart; it is therefore seldom used for general purposes. The additional wheel adds to the weight which the horse has to draw, and is an incumbrance in a ploughed field.

The addition of springs to carts and waggons is a very great improvement, and should be adopted in every case where they are much used on the roads. The additional weight and cost of the springs are greatly overbalanced by their advantage: they lessen the draught, and, by preventing jolting and shaking, add to the durability of the vehicles. Where a light active kind of horse is used which can trot with a moderate load, it will be found that there is a great advantage in occasionally increasing the pace at which empty carts and waggons are made to move. In Holland and Flanders, the waggons are always driven at a smart trot when going empty to the field in harvest or hay-making, and much valuable time is saved by this means.

For a notice of the remarkable modern improvements in agricultural carts, enabling them to supersede in great measure the heavy waggons, see AGRICULTURAL IMPLEMENTS. The chief vehicles for passenger traffic, such as hackney-coaches, cabriolets, stage-coaches, and Irish jaunting-cars, and the legislative arrangements relating to them, are treated under STAGE CARRIAGES. The manufacture of coaches generally is described under COACH MAKING, and that of wheels under WHEEL.

CARUACROL. [CARAWAY, OIL OF.]

CARUEN. [CARAWAY, OIL OF.]

CARUM CARUI (*Common Caraways*) — *Medical Properties of.* This umbelliferous plant is indigenous in most parts of the south of Europe, where its roots are used in the same way as those of the parsnip and carrot, and its fruits, incorrectly termed seeds, are collected as aromatic stimulants, for a variety of purposes. It is cultivated in England, chiefly in Essex, for the fruit alone; but much of what is used in this country is imported from Germany, where it is in exten-

sive use to form a liqueur. The fruit is too familiarly known to require description; but to secure it in perfection it must be ripe, brown, not green, and when rubbed or bruised it should emit a strong characteristic odour. This depends on the presence of a volatile oil, which exists in the proportion of 4 to 5 per cent. It is obtained and purified by repeated distillation. The officinal preparations are the oleum carui, aqua, and spiritus. For preparing the aqua two modes are given in the 'Pharm. London, 1851,' the latter of which only is ever followed: a portion of the oil dissolved, or diffused through the menstruum, is a speedy mode of obtaining the object. The oil is sometimes given dropped on sugar. The powers of caraway are similar to those of dill [ANETHUM GRAVEOLENS], and the observations there made on the use and abuse of this carminative are applicable here.

CARVENE. [CARAWAY, OIL OF.]

CARVING, the art of forming any hard materials into a proposed shape or figure by means of sharp instruments. It is usually understood to refer exclusively to works in ivory or wood, to distinguish it from carving in marble or stone, which comes under the term *sculpture*, except in the cutting of architectural ornaments, which is regarded as carving rather than sculpture. Carving in metals is called *chasing*.

The ancients used ivory to a great extent in works of art, and its union with gold, called by the Greeks *chryselephantine* sculpture, was adopted by the greatest artists. The colossal statue of the Olympian Jupiter at Elis, by Phidias, was one of the most celebrated examples of this combination. Ivory carving was practised to a considerable extent by Byzantine artists between the 5th and the 12th centuries: and again by the carvers of the 13th to the 15th centuries. The Italian renaissance carvers (from the 15th to the early part of the 17th century) executed many works of exceeding beauty—as Fiammingo, whose carvings of children have never been equalled; Pronner, of Nurmberg; Van Obstal, of Antwerp, and others. In later times carving in ivory has been for the most part confined to smaller objects, as small figures, reliefs, enrichments of flowers, fruit, and other devices on vases and cups, and such objects of general use. The instruments used for carving in ivory are very similar to those employed in working in marble, consisting of chisels of different sizes, saws, rasps, and files; the polishing is effected, as in marble, by friction.

Wood of almost every description was a favourite material for carving among the ancients; and, after clay, was doubtless, from the facility of cutting it, the first substance used for imitative art. Some figures of very remote antiquity found in the tombs in Egypt are of sycamore. In Greece many of the statues of the gods were of wood; and all those attributed to the first Dædalus were of that material, from which circumstance indeed wooden figures were called Δαίδαλα, or Dædalian. Wood seems to have been used for sculpture long after more valuable and durable materials were employed. Pliny and Pausanias describe many of these works, and mention the varieties of wood of which they were made. Among them were the oak, ebony, fir, cedar, box, citron, cypress, beech, fig, myrtle, olive, palm, poplar, vine, &c. &c.

For a long period in modern times there was a great demand for fine wood-carvings, and wherever Gothic architecture flourished there existed very skilful carvers. The elaborately worked Gothic screens, choir-seats, and desks, in most of our cathedrals and colleges, as well as in similar edifices in France, Germany, and Flanders, canopies, frames for doors and pictures, cabinets, and indeed every description of furniture, are evidence of the extent to which it was employed, and of the skill of the artists. Many of these performances display indeed more ability in the workmanship than good taste in the design, being, where figures are introduced, chiefly of grotesque and not unfrequently indelicate subjects. But there are very many specimens of chaste design, as well as careful execution.

One of the most eminent modern carvers in wood was Grinling Gibbons, a native of England. He was much employed by Charles II., particularly at Windsor Castle and Hampton Court. In London the choir of St. Paul's may be instanced as a work of this artist. Many of his best performances are at the country residences of some of the English nobility; the specimens at Chatsworth and at Petworth are admirable imitations of nature. In our own day the art has been revived, and there are at present in this country some excellent carvers in wood. Much of the hand-cut carving at the New Palace of Westminster is very beautifully executed; and in the present year (1859) Mr. W. G. Rogers, to whom the revival of the art of wood-carving in England is to a great measure due, has carved in oak, in a very beautiful manner, the entire fittings of a church (that of St. Michael's, Cornhill), being the first complete work of the kind probably executed in England since the decline of Gothic architecture. Architectural sculpture, or carving in stone, has also been of late practised with great spirit and feeling, and many such works now deserve to take rank as works of fine rather than mechanical art, as they used to be considered a few years back.

The woods preferred by modern carvers are the pear, lime, American pine, maple, oak, and box: and the tools they employ are round hollow chisels called gouges; others with an angular extremity called from the shape V tools; flat chisels of various sizes, and files. A mallet is sometimes used, but pressure, or a sharp blow from the bottom or heel of the hand, is generally preferred. The surface is cleaned and polished with sand-papers of different qualities, by pumice-stone, and by friction.

Wood Carving by Machinery.—Within the last few years machinery has been applied to the carving of wood. The display of true artistic feeling in carving is only possible where each specimen is made by hand, and is regarded as a work of art by its producer; but where a great number of duplicate copies is needed, the work becomes a sort of manufacture, to which machinery may be applied. In Jordan's carving machinery the wood has movement given to it, while the tools remain nearly stationary. A pattern of the work to be carved is first modelled by the artist, and afterwards copied by the machine in wood with perfect accuracy, and in such a manner that two or three copies are made simultaneously; the carvings thus prepared by the machine are then sent back to the artist, who introduces by hand the finishing touches. A very large amount of the carving in the new Houses of Parliament has been effected by this machine. The more delicate work for the same building, requiring hand-processes, as already mentioned, was entrusted to Mr. Rogers.

About the year 1846 Mr. Pratt patented a carving-machine, which was based on another patent machine, invented by Mr. Irving, for preparing the materials for inlaying. According to a description given of it before the Institute of British architects, Mr. Pratt's machine combines the principle of the lathe, the drill, and the pantograph. The material on which the design is to be carved is fixed on a table which turns on a centre. The tool, acting in the manner of a centre-bit, is attached to an arm, also working on a centre, and is made to revolve with great velocity. Guided by a pattern of cast-iron, the tool, by a double movement of the arm and the table, can be made to pass through any combination of curves, drilling out the material as it passes over it. The lines of the design are determined by the iron pattern, and the depth and form of the sinking by the shape and position of the tool; and if a double moulding is required, two patterns and two tools and a double operation are necessary. The tool and its position at the end of the arm being once adapted to the section of the moulding to be produced, the rest is purely mechanical; the workman guides the tool with one hand, and the table with the other, and the design comes out with great rapidity. The tool revolves three thousand times in a minute, and the wood is cut away in the form of very fine fragments, like sawdust, leaving a smooth surface behind it. The machine will cut stone with nearly the same facility as wood.

A kind of imitative carving was introduced a few years ago, in which a hot iron is employed instead of a cutting tool. An iron mould is prepared corresponding to the pattern to be produced, and this mould, being heated to redness, is applied with great force to the surface of a piece of damped wood; this process is repeated until the required form is produced, by burning away the surface of the wood. The char is then removed, and any requisite undercutting is done by hand. When finished, the work has somewhat the appearance of old oak, and the surface may be brought to a high polish.

CARVOLE. [CARAWAY, OIL OF.]

CARYA'TIDES (Καρυάτιδες), female figures employed in architecture in place of columns, like Atlantes and Telamones. Vitruvius (b. 1, c. 1) attributes the origin of caryatid figures to the circumstance of the inhabitants of Caryæ, a city of Peloponnesus, taking part with the Persians during the invasion of Xerxes, and their consequent punishment: the men were slain, and the women carried into captivity; and their ignominy was perpetuated by the employment of figures, similar to the women of Caryæ, in place of columns. This story however, is hardly worth relating. It has sometimes been conjectured that these figures represent the virgins who celebrated the worship of Diana; while others have thought that they represent Athenian virgins carrying on their heads the sacred vessels used in religious ceremonies. The use of caryatid figures is far more ancient than the date of the story told by Vitruvius; like many other forms of art, they were no doubt derived by the Greeks from Egypt. [ATLANTES.]

Six beautiful caryatid figures were employed in the Pandrosion, one of the buildings on the acropolis of Athens. The northern portico of the Pandrosion had six Ionic columns, four in front, and one on each flank: the southern portico was supported by six caryatid figures, four in front, and one on each flank. They were placed upon a basement, and supported an enriched entablature. (Stuart's 'Athens,' vol. ii. Plates.) One of the figures is now in the British Museum among the Elgin collection. The execution of this figure is extremely fine; its height is seven feet nine inches. Three of the caryatides remain in their original position, but greatly mutilated.

At the sides of the New Pancras church, London, and at the east end, are two projecting wings with four caryatid figures in each. The whole is an imitation of the Pandrosion; but the figures are very ill executed, and it need hardly be remarked how very incongruous such figures appear as parts of a Christian church. These excrescences form the entrance to the places of sepulture under the church.

Another caryatid of a much later style of art, representing a female of heroic size, of a grave and dignified appearance, is in the third Græco-Roman saloon in the British Museum, and being nearly perfect shows better than the former the character of these figures, though inferior to it as a work of art. This figure is draped with the diploidion or double tunic, with a kind of peplus fastened on the

shoulders by fibulæ, and is adorned with earrings, necklaces, and bracelets. On her head she carries a modium, which originally supported part of the entablature of a portico. It was found with three similar figures in 1766, on the site of a temple, supposed from the occurrence of a figure of Bacchus to have been dedicated to that deity, near the Via Appia, a few miles south-east from Rome; it was purchased by Mr. Townley, with the rest of whose collection it was bought by the Government in 1808.

[Caryatid figure from the Pandrosion, now in the British Museum.]

[Caryatid, from the Townley Collection, now in the British Museum.]

CARYOPHYLLIC ACID, *Eugenic acid* ($C_{20}H_{12}O_4$). The volatile essential oils of cloves, pimento, and cinnamon leaf, are chiefly composed of a hydrocarbon isomeric with oil of turpentine, and an oxygenated oily body, caryophyllic acid.

When either of these oils is mixed with caustic potash or soda and submitted to distillation, the hydrocarbon is volatilised and the caryophyllic acid remains in combination with the alkali, forming a butyraceous crystalline mass. This residue distilled with sulphuric acid, yields the caryophyllic acid in a nearly pure state.

Caryophyllic acid is a colourless oily liquid, in taste and smell much resembling oil of cloves. It gives an acid reaction with litmus paper. Its specific gravity is 1·079; boiling point, 436° Fahr.; vapour density, 6·4. It rapidly absorbs oxygen from the air, becoming resinified. When required quite pure it must be redistilled in an atmosphere of carbonic acid.

Caryophyllic acid forms salts with most of the bases. Brought into contact with caustic potash, soda, ammonia, baryta, strontia, or lime, it unites to form crystalline compounds containing an equivalent of basic metal in the place of an equivalent of hydrogen. The soluble caryophyllates give, with solution of acetate of lead, a light yellow precipitate; with sulphate of copper, light-blue; with protosulphate of iron, lilac; and with persulphate of iron, red changing to violet and blue.

Some interesting derivatives of caryophyllic or eugenic acid have been obtained by M. Cahours, by reaction with the chlorine compounds of organic acid radicals. The following neutral substances have been thus obtained, hydrochloric acid being produced at the same time:—

Benz-eugenyl	$C_{34}H_{16}O_6$
Tolu-eugenyl	$C_{36}H_{18}O_6$
Cum-eugenyl	$C_{40}H_{22}O_6$

CARYOPHYLLIN ($C_{20}H_{16}O_2$). A solid, white crystalline substance found in cloves. It crystallises from a strong alcoholic infusion, or may be precipitated by the addition of water to an ethereal infusion Resin, with which it is generally contaminated, may be removed by boiling with caustic soda or ammonia. It has the appearance of silky needles, which, if pure, sublime at a high temperature without decomposition. Caryophyllin is freely soluble in hot alcohol or ether, from which solution the greater part crystallises out on cooling. It is insoluble in water. Caustic alkalies and strong acids dissolve without decomposing it. With concentrated sulphuric acid it gives a red solution which decomposes when boiled. Nitric acid converts it into a resinous substance.

CARYOPHYLLUS AROMA'TICUS, the clove-tree (in Botnay), is an evergreen small tree, belonging to the natural order *Myrtaceæ*, with opposite, ovate-lanceolate, shining, leathery, stalked leaves, and a short terminal cluster of flowers. The flower-stalks are green; the calyx consists of a brownish-red cylindrical tube, terminated by four ovate teeth; there are four small greenish concave petals, and a large cluster of yellow stamens. The fruit is an oblong one-seeded purple-berry, crowned by the persistent teeth of the calyx. All the parts are, as in other true myrtaceous plants, covered with dots containing the essential oil peculiar to the species. The clove is a native of the Moluccas, whence it has been carried to all the other tropical parts of the world. Captain Owen's people found it apparently wild even upon Fernando Po, whither it had been probably transported by the Portuguese. The cloves of the spice shops are the flower-buds of this plant, gathered before they open, and dried in the sun; the round ball at their ends is the corolla inclosing the stamens; the quadrangular part below is the tube of the calyx; and the four teeth are the divisions of the calyx. The name *clove* is a corruption of the French word *clou*, a nail, a name that has been suggested by the resemblance of the dried clove to such a thing. The aromatic stimulating effects of cloves are well known. For a good account of their introduction to Europe, consumption, &c., see 'Botanical Magazine,' vol. liv. t. 2750. By some modern botanists, the genus *Caryophyllus* is reduced to *Eugenia*.

The *Caryophyllus aromaticus* grows naturally in New Guinea and the Molucca islands, from which last exclusively Europe was supplied for a long time. About 1769, the French introduced it into the Isle of France, of Bourbon, and the Sechelles, and in 1771 into Guiana. In 1798, the cultivation of this tree was extended to Sumatra, and

very lately it has been introduced into Brazil. A tree 12 years old will yield from 5 to 20 pounds of cloves annually; when older it may

yield about 60 pounds, after which the quantity again diminishes. But as a single stem may live 150 years, it may furnish during that time 1100 pounds of cloves. Each clove is about half an inch in length. The external colour is dark brown, appearing as if covered with dust or little warts, with a somewhat fatty coating. When broken across, the appearance is decidedly oily, and oil quickly exudes from the exposed broken surfaces. The odour is strong and peculiar, but agreeable; the taste aromatic and burning.

Several varieties of cloves are found in the market. The difference of colour is attributed to the different season of the year when the gathering was made. 1st. Soft cloves, called also the Dutch Company's cloves; these have generally been distilled once, and have but a faint odour and taste. 2nd. Dry cloves, which are mostly distinguished according to their place of growth. The English Company's cloves, which are the finest sort, are of a large size, and of a bright reddish-brown colour. The Amboyna are probably the soft Dutch cloves. The Bourbon cloves are small; those of Guiana are still smaller; these two last-named sorts are chiefly used to mix with the former and finer kinds. Analysed by Trommsdorff, 1000 parts yielded of—

Volatile oil	180 parts
Scarcely soluble extractive	40
Gum	130
Resin	60
Tannin	130
Lignine	280
Water	180

The volatile oil seems to be of two kinds, respectively termed: light oil of cloves, a hydro-carbon, isomeric with oil of turpentine; heavy oil of cloves, called also clove acid, caryophyllic acid, and eugenic acid. It is this oil which has an acid re-action, and combines with alkaline bases. It is essential to be acquainted with it and its properties, as in some analyses its presence gives rise to a supposition of opium being in the stomach. Eugenin is the stearopten of oil of cloves. Caryophyllin is clove sub-resin. Clove tannin has some slight points of difference from other kinds of tannin.

By distillation a thickish oil is obtained, which is at first colourless, but by time becomes yellow and brown. Its odour partakes strongly of that of cloves; its taste is very fiery and aromatic; it re-acts as an acid. In time there separates from it a stearopten or clove-camphor, called *caryophyllin*. This principle may be procured in greatest quantity from the English Company's cloves; more sparingly from the Bourbon and Cayenne cloves; in some it appears to be altogether wanting. Owing to the presence of so much oil, cloves cannot be powdered without adding some gum or sugar during the process.

Cloves are employed in medicine, and also more extensively for culinary purposes. When received into the stomach they are powerfully stimulant, and promote digestion when taken along with food which is insipid or difficult of digestion. Though the action is generally limited to the stomach, yet if taken in excess, or the use very long

continued, it extends to the brain, causing giddiness and other inconveniences. Cloves may be given in powder, along with gum, in very moderate doses; but the infusion is a preferable form. Infusion of cloves is a grateful gargle to persons salivated by mercury. Either alone, or when made the vehicle for carbonate of ammonia, nothing so effectually and safely removes that feeling of coldness and weight about the stomach experienced by hysterical or gouty persons, and renders it unnecessary to have recourse to alcoholic stimulants, such as brandy, which is too frequently employed under such circumstances. Oil of cloves is used to drop into decayed teeth, and also is given along with many purgative and other medicines to correct their griping tendencies.

The fruit of the clove, called the mother clove, possesses little odour or acrimony; but when preserved with sugar, it forms a good condiment to be eaten at dessert by persons with weak digestion. What is called the royal clove is merely a monstrous variety of that above described.

The buds of the *Calyptranthes aromatica* are employed in Brazil as a substitute for those of the *Caryophyllus aromaticus*. The botanical portion of this article was accidentally omitted in the Nat. Hist. Div., and has therefore been supplied here.

CASCARILLA BARK. Whatever doubts may have existed respecting the plants which yielded this bark, or its course to Europe, seem now entirely dissipated by the researches of Dr. Wm. Freeman Daniell, staff-surgeon, while stationed in the Bahama Islands, and the botanical commentaries of Mr. J. J. Bennett, secretary to the Linnæan Society. It appears that three distinct species of the genus *Croton*, yield cascarilla bark. Of these, two are natives exclusively of the Bahama Islands, one common to the Bahama Islands and Jamaica. Of these is—

1. *Croton Eluteria*, Bennett; synonymous with *Eleuteria providentiae*, folio cordato subtus argenteo; Sweet bark, seu cortex beneolens, of Petiver's collection, 4 n. 276; *Eleutheria*, Linn. Hort. Cliff. p. 486; *Clutia Eluteria*, L. 'Sp. Plant.,' ed. 1, p. 1042 (excl. synon. omn. præter Hort. Cliff.); *Clutia Eluteria*, s. Cascarilla, Woodv. 'Med. Bot.' p. 633 t. 223, f. 2. Grows in the Bahama Islands; Catesby, Dean, Dr. W. F. Daniell.

2. *Croton Cascarilla*, Bennett; synonymous with *Ricinoides elæagni folio*, Plum. Spec. 20, Icon. p. 236, t. 240, f. 1, Catesby 'Cardl.' vol. ii. t. 46; *Clutia Cascarilla*, L. 'Sp. Plant.' ed. 1, p. 1042. Grows in the Bahama Islands, Catesby; Providence, Dr. W. F. Daniell.

3. *Croton lineare*, Bennett; synonymous with the plant in Sloane's 'Hist. of Jamaica,' i. p. 133, t. 86, f. 1; *Croton fruticulosum*, Browne 'Jam.' p. 347; *Clutia Cascarilla*, Linn. 'Amœn. Acad.,' v., p. 411, and the specimen so named in the 'Herbarium' of Linn.; *Croton lineare*, Jacq. 'Amer.' p. 256, t. 162, f. 4, Pict. p. 124, t. 263, f, 80; and with *Croton Cascarilla*, Woodv. 'Med. Bot.' p. 629, t. 222. It grows in Jamaica (Sloane, Houston, Wright), and in the Bahama Islands, Catesby, Daniell.

4. *Croton Sloanei*, Bennett; synonymous with the plant in Sloane, 'Jamaica,' ii., p. 30, t, 174, f. 2; *Clutia Eluteria*, Linn. 'Amœn. Acad.' v., p. 411, Linn. 'Herb.;' *Croton Eluteria*, Swartz, 'Flor. Ind. Occid.' p. 1183, Wright in Med. Journ. viii. p. 3, Woodv., 'Med. Bot.' p. 634, t. 223, f. 1 (very bad fig.), Hayne, Arzneygen. xiv. t. A native of Jamaica; assigned by most writers as the source of cascarilla; probably yields none of the bark of British commerce, though some of the continental cascarilla may come from it, as well as *Croton micans*, L., another Jamaica species. Swartz's plant is the "wild rosemary" of the West Indies. The plant assigned by the late Prof. Don as the source of cascarilla, is the *Croton Pseudo-China Schlectendal*, a native of Mexico, and in the shops of Jalapa is known as the *Quina Cluca*, or *Copalchi*. Some of this has been brought to Hamburg as the *Cascarilla de Trinidad*. It corresponds in appearance with the Ash Jaen, or (corruptly Ten) bark, the produce of some species of *Cinchona*, to the barks of all which the term *Cascarilla* or *little bark* is given in South America, leading to much confusion, and lending countenance to the idea that cascarilla bark comes from Lima.

There is a corky copalchi bark yielded probably by *Croton sulcerus*, Humb.; but it has none of the aromatic taste of true cascarilla, though in burning it gives out an aromatic odour. It comes from Chili, under the name of *Natri*. (Pereira, 'Materia Med.')

The bark occurs in pieces from one to four inches long, which are tubular or overlapping; externally covered with a cuticle, which easily peels off, so that the liber or bark is often exposed, in which case it feels soft and cork-like. The colour externally is yellowish, ash-gray, or varying to reddish brown; this last colour is mostly owing to the presence of lichens. The surface is also marked by irregular, deep, longitudinal furrows. The inner surface is a dirty or rusty brown colour. Odour faintly aromatic; taste bitter, not unpleasant, and stimulating. No alkaloid has been detected in it, but it possesses much volatile oil; one pound of bark yields one drachm and a half of volatile oil. This bark is sometimes mixed with the cinchona barks, being called gray-fever bark; a substitution in no respect hurtful.

The action of cascarilla on the human system depends partly on its bitter principle, and partly on its volatile oil: by the former it approaches the pure bitters; by the latter, the aromatic stimulants. It possesses this great advantage over almost all other tonic medicines, that it is more easily digested by the stomach, when no other affection

of that organ exists than debility and inactivity. This property can only be imparted to other tonics by the addition of aromatics, while it is possessed naturally by this spontaneous combination. In the treatment of pure indigestion from weakness of the stomach and alimentary canal, cascarilla merits the preference. It is likewise of much utility in the treatment of intermittent and nervous fevers, and chronic diarrhœa dependent upon debility; provided no inflammatory condition of the mucous membranes of the stomach or intestines co-exists.

Powder, or a cold infusion, is the best mode of administration; decoction is objectionable from dissipating the volatile oil. From its pleasant aromatic odour it constitutes an ingredient in *fumigating pastiles*. On its first introduction into England, it was used to mix with tobacco, a use to which it is still put in Germany; but a large quantity of it so used is productive of giddiness and stupefaction—not free from danger.

For the botanical details above cited, see 'Journal of Proceedings of Linnæan Society of London,' vol. iv. p. 29, 1st July, 1859.

CASCARILLIN. The bitter principle of cascarilla, the bark of a euphorbiaceous tree, the *Croton eleuteria*. It crystallises in colourless prismatic needles, and sometimes in hexagonal plates. It is bitter to the taste but inodorous, very slightly soluble in water, but soluble in alcohol and ether. Sulphuric acid dissolves it with the production of a very intense red colour: on the addition of water a precipitate is formed which communicates a green colour to the solution. Hydrochloric acid also dissolves cascarilla with a violet tint, the addition of a little water changes this to blue, whilst a larger quantity produces a green coloration. The composition of cascarillin is unknown.

CASE, ACTION UPON THE, is one of the forms of action by which a remedy for certain civil injuries might be obtained. It owes its origin to the Statute of Westminster the Second; and derives its name from the circumstance that in the old form of the writ or process, which formed the commencement of the suit, the particulars of the wrong complained of, or the *case*, were set out in detail with nearly the same precision as in a declaration. (Blackst., 'Comm.,' Mr. Kerr's ed., vol. iii. p. 129, n.)

CASE, IN GRAMMAR. [Ablative Case.]

CASE-HARDENING is an important process in the steel manufacture; or, rather, it is the imparting of a steel surface to iron goods, such as workmen's tools, fenders, fire-arms, keys, and cheap cutlery. The goods, when finished, except polishing, are exposed to a high heat in contact with certain other substances. The most usual substance is animal or vegetable charcoal, in a pulverised state. Sometimes the agent consists of a composition of horn, bay salt, and white wine vinegar; and other kinds are occasionally used. If the process be well conducted a thin film on the surface of the iron has been converted into steel, and acquires a degree of hardness sufficient to resist the action of an ordinary file. The relation which this process bears to the manufacture of steel proper will be seen in a later article. [Steel.]

CASE-SHOT are bullets contained in a cylindrical tin canister, or in a spherical shell of iron, which are discharged from a piece of ordnance. The first of these kinds of case burst immediately on leaving the gun, and the bullets commence diverging almost immediately in all directions, and soon lose all regularity of motion; and though they do great execution among the troops of an enemy within the limits of their effective range, that range, which does not exceed 500 yards, is in general of too small an extent. The divergency of the balls is said to be less when they are put into the case in tiers than when thrown in at random; and it is further lessened when the bottom of the case is formed of a strong plate of iron.

The spherical case-shot (the second kind above mentioned), which are also called Shrapnell shells from the name of the inventor, are fired like common shells, and the length of the fuse being properly regulated, they only burst at the required spot; and the liberated bullets and the fragments of the shell spreading out and going with the velocity communicated to them by the gun, may be made to take full effect in a column of an enemy's troops at 800 or 1200 yards distance, or whatever is the effective range of the particular gun. For further particulars, see Shrapnell Shell.

CASEIC ACID. [Cheese.]

CASEIN, the characteristic nitrogenous constituent of milk. It forms the greater part of cheese. It has already been noticed [Albumen] as one of the albuminoid or protein group of substances, and is closely allied to the other members. It contains no phosphorus. According to Mulder, it is composed of—

Carbon	54·2
Hydrogen	7·2
Oxygen	22·4
Nitrogen	15·8
Sulphur	0·4
	100·0

It has been asserted that casein exists in two states,—one in which it is soluble in water, and another in which it is insoluble. Soluble casein, however, has never been obtained free from alkali; and it is more than probable that, as in milk, it is the alkali that renders it soluble.

Casein is best prepared by gently warming fresh milk with a small quantity of dilute sulphuric acid, well washing the coagulum that separates, dissolving in a sufficient amount of concentrated solution of carbonate of soda, and setting aside for some time exposed to a temperature of about 70° Fahr., in order that fatty matter may rise to the surface and remain behind when the alkaline solution of casein is removed by a siphon. Re-precipitation by acid and re-solution in alkali must be gone through several times, and the final curdy precipitate well washed with water to remove the last portions of acid, and with alcohol and ether to separate traces of fat.

Moist casein reddens litmus paper. It may be readily dissolved in water containing a small quantity of alkali or alkaline carbonate. From this solution it is re-precipitated by an acid or by strong alcohol. Albumen, it will be remembered, is not precipitated by acetic acid, which re-action serves to distinguish casein from that substance, added to which, solution of casein is not, like albumen, coagulated by heat.

The most interesting property of casein is the facility with which it is coagulated by the mucous membrane of the fourth stomach (*rennet-bag*) of the calf, or rather by the soluble matter (*rennet*) produced by the slow decomposition of that membrane. A small piece of the dried stomach allowed to digest a short time in a little water, yields a liquor which, added to two or three thousand times its volume of warm milk, soon causes perfect coagulation, the mixture popularly known as *curds and whey* resulting. This is, as is well known, one of the first steps in the process of cheese-making. Liebig's explanation of this reaction is, that the membrane altered by exposure to the air and moisture acts at the slightly elevated temperature as a ferment, transforming the milk-sugar into lactic acid, which, after the same manner as other acids, precipitates the casein. This theory is supported by the fact, that the mixture, after coagulation, always presents an acid re-action; but at the same time it must be borne in mind that the same effect of curding occurs at a little higher temperature, when a sufficient amount of carbonate of soda has been added to produce a permanent alkaline re-action. Further investigation will no doubt throw full light on this remarkable change.

Solution of casein affects polarised light in the same manner as albumen, and in its deportment with chemical re-agents much resembles that substance. With lime it forms an insoluble and very stable compound used in encaustic painting. It admits of being easily moulded, and receives and retains colours exceedingly well.

CASEMATE, a vault of stone or brick-work, generally built in the thickness of the rampart of a fortress for the reception of artillery which is to fire through embrasures pierced for the purpose in the front of the vault.

The smallness of the flanks in the ancient bastions, and consequently the insufficiency of the fire from their parapets, gave rise to the invention of casemates which, being formed under those parapets, augmented the means of defending the ditches without rendering any change necessary in the size of the works. Casemates so situated exist in the flanks of the Tower bastions, in places fortified according to the second system of Vauban; and at New Brisach they are formed both in the flanks of the bastions and in those of the intermediate curtain.

Buildings of this nature appear to have been executed as early as the 16th century, for they are mentioned by the Italian engineers of that age; and, as it was foreseen that the smoke arising from the discharge of artillery in the vaults might, after a short time, render them untenable, Castriotto recommended that only cross-bows or engines for throwing stones should be placed in them.

In the works of Vauban casemates have also been constructed under the parapets in the flanks of the ravelins and of their reduits, for the purpose of defending the ditch and of co-operating with the flanks of the bastions in opposing the construction of the besieger's counter-battery whose situation is indicated at H [*Fig.* 1, Bastion].

Besides the supposed inconvenience on account of the smoke, casemates in such situations, their front walls being unavoidably weakened by being pierced with embrasures, are liable to be destroyed in a short time by the direct fire from the counter-batteries, when the roofs, in falling, may bring down with them the parapet above. To avoid this evil, engineers have proposed that the casemates in the flank of a bastion should be covered by the tenaille [P, *fig.* 1, Bastion]; in which case a fire of shells is to be directed over the tenaille when it is intended to oppose the enemy in the formation of his lodgments.

A difference of opinion has existed concerning the impediment which might be produced by the smoke in the service of the guns; and in the year 1800 an experiment was made by the French engineers in order to determine the question, in the casemates of the Tower bastions at New Brisach, by firing 60 rounds from two pieces in half an hour. Each of these casemates has a perforation in the front wall, above the embrasure, and an ordinary chimney in the wall opposite the front; and during the firing the door between the casemates was kept open. No considerable inconvenience was experienced by the officers who were present; and as the service of guns in casemates so situated can never be required for a longer time, it seems evident that the apprehensions entertained on this subject are without foundation.

Similar experiments have been made in the casemates of Fort Ricasoli at Malta, and the smoke went off very freely; but these, besides having an air-hole in the front wall, are open towards the rear. The casemates proposed by Bousmard to be built in the flanks of his tenailles are ventilated in the same manner; and those exhibited in the system of

Carnot are entirely open both in front and rear; the mortars or howitzers being masked by a wall over which the line of fire is to be directed.

The term casemate is also applied to the shell-proof vaults of stone or brick constructed in fortresses to protect the troops, provisions, and ammunition. These are usually formed on the fronts which are least exposed to the enemy, and within the masses of the ramparts either of the bastions or curtains in order that they may be sufficiently protected from the effect of shells falling on them; attention should also be paid in constructing them that their interiors be dry and well ventilated. For the latter purpose, they may have perforations in the front walls; and to render them waterproof, the upper surface of the vault is usually covered with cement. That surface is in the form of two inclined planes meeting in a ridge over the crown, and the ridge as well as the gutter between every two casemates, is covered with lead. Drains are formed in these gutters to carry off the rain; to facilitate the descent of which into them, courses of dry bricks or beds of gravel are laid on the exteriors of the vaults; over these is a covering of clay and earth, terminating above in a level surface. (Colonel Pasley's 'Elementary Fortification,' vol. ii. p. 367.) It was from the humidity as well as from the crowded state of the casemates at St. Philip's Fort in Minorca, and the consequent sickness among the troops, that the governor of that post was compelled to surrender it when it was besieged by the Spaniards in 1782.

When casemates are built for troops, they should be 16 feet wide, in order to allow room for a double row of beds with a passage along the middle; and on the hances of the vault (the weakest part) the brick work should be about three feet thick. Those at Gibraltar are from 16 to 18 feet wide in the interior, and 16 feet high from the floor to the crown of the arch, which is semicircular, and they are from 40 to 100 feet long; some of them have air-holes in front, with chimneys through the roof, and the back walls have doors and windows which may be kept open while the firing is continued. The vaults of the casemates on the western heights at Dover are parabolical; the whole interior height is 17 feet, the breadth 18 feet, and the rise of the curve is 9 feet from the springing courses.

CASH-CREDIT. [BANK; BANKING.]

CASHMERE, or CACHEMERE, a peculiar textile fabric formed of the fine downy wool found about the roots of the hair of the Tibet goat. [GOAT, NATURAL HISTORY DIVISION.] It is so called from the original seat of the manufacture, in the valley of Cashmere, in the north-west of India. Shawls of exceedingly delicate quality are the principal articles manufactured of this material; but a cloth woven in imitation of them is also made. There has been some discussion among persons engaged in the cloth manufacture whether the two names *Cassimere* and *Kerseymere* are merely two forms of spelling the same name, or whether they relate to two distinct kinds of fabric. It is now supposed that *Cassimere* was a corruption of Cashmere, and was the name given to the cloth woven in imitation of Cashmere shawls; whereas *Kerseymere* took its name from the village of Kersey in Suffolk.

An interesting description of the manufacture of Cashmere or Kashmir shawls is given in Vigne's 'Travels in Kashmir,' from which it appears that the thread is dipped in rice-water before weaving, by which process it is made stronger, the stiffness thus imparted being subsequently removed by washing. Of the actual process of weaving we find no satisfactory account. The needle is occasionally used in the production of the patterns; but Vigne observes, that "if the pattern be worked with the needle the shawl is far inferior, in every respect, to those in which the pattern is woven in," and that "an excellent pair (the shawls being always made in pairs) of the former description may be purchased in Kashmir for 150 rupees (about 10*l.*), whereas an equally good pair of the usuleh (the real), or the latter kind, could not be procured for less than 700 or 800 rupees." The process is exceedingly slow, the weaving of a pair of shawls, or, as some writers have it, of a single shawl, often employing three men with a clumsy old-fashioned loom for a period of six months; and owing to the numerous heavy duties charged upon the shawls between leaving the loom and reaching a purchaser in this country, the price of real Cashmere shawls of the best quality is very high. They have frequently been sold in London at from 100 to 400 guineas each; and in one instance, when the import duty, which has since been greatly reduced, amounted to 80 per cent. on the value, as much as 500 guineas was demanded for a single shawl.

The peculiar softness of Cashmere shawls appears to be in some degree attributable to the process of washing to which they are subjected after weaving. "The best water for this use," observes Vigne, "is found in the canal between the lake and the floodgates at the Drogjun." "Some ruins, in large limestone blocks, are lying on the washing-place, and in one of these is a round hole, about a foot and a half in diameter and a foot in depth; in this the shawl is placed, and, water being poured over it, it is stamped on by the naked feet for about five minutes, and then taken into the canal, by a man standing in the water: one end is gathered up in his hand, and the shawl swung round and beaten with great force upon a flat stone, being dipped into the canal between every three and four strokes." The shawls, if coloured, are then dried in the shade, as the hot sun would injure the colours, and about ten days afterwards the same process is repeated though for a less time. White shawls, however, after being treated in like manner, are spread in the sun, and bleached by sprinkling water upon them; and the alternate washing and beating, and drying and bleaching in the sun, are repeated three times, soap being occasionally used in the second washing and stamping. "There is something in the water of the canal," observes the same authority, "which certainly communicates to the shawl a softness which cannot be given to those manufactured at any place in the plains of Hindustan." "At the same time," he adds, "those made in Paris or at Norwich would be, I think, as soft, were it not for the greater closeness of texture, consequent on their being made by a machine instead of the hand." "For the same reason," he proceeds, "it is well known that the calico made in India is much softer, and is much more durable, than that made in England." The water is readily found near the surface of the ground, is bad tasted, and, Vigne believes, brackish. Old shawls that require cleaning, and sometimes also new ones, are washed by means of the freshly-gathered root of a parasitical plant called *kritz*. A pound of this is bruised and mixed with about three pints of water, to which is added a piece of pigeon's dung, equal in size to a turkey's egg, beaten up in about an equal quantity of water. The shawl is saturated with this liquor, stamped upon, washed with the hand, and then steeped in the canal. By a peculiar process, a fine pale yellow colour is given to the shawls by the fumes of sulphur. A cloth called siling is manufactured from the shawl wool in Yarkund and China, which resembles a coarse English kerseymere in texture.

Various attempts have been made to naturalise the Cashmere shawl goat in this and other European countries, but as the peculiarities of its wool appear to be dependent upon climate, the perfect success of any such attempt is problematical. The wool itself has also been imported as a raw material; and the late Dr. Ure gave an account of the various plans adopted in France for working both the imported wool and that produced in France from a breed of Tibet goats imported in 1819, into shawls in imitation of those of Cashmere, in which plans the Jacquard loom has been employed to great advantage. In the shawl manufacture in Scotland, attempts have more than once been made to introduce either the real Cashmere wool itself or some effective substitute for it. In the year 1830, at which time the weaving of shawls from Cashmere yarn imported from France had become an important branch of manufacture, a premium of 300*l.* was offered by the Board of Trustees for the Encouragement of Arts and Manufactures in Scotland, to the person who should first establish the spinning of Cashmere wool upon the French principle. In consequence of this offer, Captain C. S. Cochrane devoted himself to the subject, and having succeeded, after some difficulty, in obtaining a knowledge of the secret, he patented the plan, and subsequently sold his patent to the Messrs. Holdsworth of Glasgow, who established the manufacture successfully, and obtained the offered reward in 1832. Judging from an experiment recently (1858) made with the alpaca, there is a possibility that the Cashmere goat may one day be introduced in Australia.

The various woven goods called "Cashmeres," like "alpacas" and "merinos," too frequently have little or no claim to the designation; they are imitations, ingenious enough if they were but called by their right names.

CASK-MAKING. [COOPERAGE.]

CASSATIO'N, "the reversal of a judicial sentence," is a French law word, derived from "cassare," which, in the barbarous Latin of the lower ages, was synonymous with "irritum reddere," in which sense, as Ducange shows, it frequently occurs in ancient royal edicts; thus we find it in a charter of Offa, king of the Mercians, A.D. 790; and in the 'Life of Canute, king of the Obroditæ,' c. 4, s. 17, it also appears as a technical term, signifying to cancel or annul; and was applied as well to the annulling of private deeds, such as wills, as of municipal charters and corporate statutes, see Ducange, sub verb. cassare (2). But the word is of still older date than the documents Ducange refers to; for it appears in several places in the Theodosian Code, in the sense of annulling and abrogating.

The origin of this institution, like most of those which date from the middle ages, is involved in much obscurity, but the different stages through which it went may be briefly noticed.

1. During the whole period when trial by battle was in vogue, there was but one mode of appeal against the decisions of a judge, being that of challenging such judge to single combat; whilst a direct appeal to the suzerain, or feudal chief, was allowed in one case only, that of a denial of a hearing, but—

2. When the system of judicial combats, or trial by battle, was abolished by Saint Louis (A.D. 1260), a change with regard to appeals was introduced, and not only was permission then given to the unsuccessful party to appeal to a superior judge, but he was enabled to demand from the judge or judges by whom his cause had in the first instance been heard, an amendment of his or their decision; hence, in process of time, not only was the power of appeal affirmed, but the mode became altered until—

3. At the commencement of the 14th century, the hearing of appeals and the power of judging "en dernier ressort," was lost by the royal judges, and became vested in the parliament, from whose decisions there was no appeal; though—

4. Provision had been made and sanctioned by royal authority, between the years 1302 and 1344, to meet the case of errors or ambi-

guities in these parliamentary decisions. The process by which this was done, known at first under the name of "lettres de grâce de dire contre les arrêts," and afterwards under that of "propositions d'erreur," was ruled by the ordonnance of 1344, which established the principle that the decisions of the parliament could only be reviewed by a "proposition d'erreur," or by special letters to be referred to and heard by the "conseil du roi," and then to be returned to the parliament, by whom the errors, if established, were to be amended.

5. From this period then dates, and to this ordonnance is to be ascribed, the form of appeal which eventually arrived at the process adopted by the cour de cassation. Sufficient has been said on the subject of the origin of this system, nor is it necessary to dwell upon the alterations that took place in consequence of abuses, alterations effected by the vigour of Olivier and L'Hôpital, and framed into the ordonnance of 1579.

By the order of procedure established under Louis XIV., in 1667, two modes of setting aside the decisions of the parliament were finally adopted; one was by "requête civile," which annulled a decision and restored the parties to their previous condition, in consequence of either fraud or legal mistakes being discovered in the proceedings; and the other was by "cassation," in consequence of a violation of either the principle or form of the law in the decision of the court. In the latter case the cause was tried anew in a council consisting of the chancellor, the four secretaries of state, the council of state, and the maîtres de requête. The national assembly, in November, 1790, having abolished this system, and established a distinct, permanent, and independent court, called Tribunal de Cassation, by a senatûs consultum of the 20 Floréal, year XII., declared the precise position, and marked the limits, of the new tribunal, which afterwards received its full organisation under Napoleon, and has ever since continued under the name of Cour de Cassation. It is the highest court of France, receiving appeals from all other courts, and may be defined in the words of the Constitutional Act of the 22nd Frimaire, year VIII., as "a tribunal which pronounces on applications to quash the judgments given by tribunals of last resort. It does not go into the merits, but quashes judgments in cases where the forms of procedure have been violated, or which are founded on erroneous interpretation of the law, sending back the merits to the tribunal which is to take cognizance of them." (Acts 65 and 66.) It consists of forty-eight members, who, by the charter of Louis XVIII., are appointed by the sovereign, but retain their places for life. The court has its president, although on certain occasions the keeper of the seals, or minister of justice, has the right of presiding in it. It is divided into three sections: 1°. Section des Requêtes, which examines whether the petitions or appeals are to be received. 2°. Section de Cassation civile, which decides upon appeals in civil cases. 3°. Section de Cassation criminelle, which decides upon appeals in criminal matters. The sections do not decide upon the main question, but only on the competency of the other courts, and the legality of the forms and principle of law by which the case has been already tried. If the law is found to have been violated, the sentence of the inferior court is annulled, and the case is sent to be tried again by another court. If this second court decides the case in the same manner as the first, and a petition against the decision is again laid before the Court of Cassation, then the three sections unite together in order to examine the case anew, and if they find reason to pass a second reversal, the case is sent to be tried before another court. Should this third court decide in the same manner as the other courts, and a petition against the decision be again presented to the Court of Cassation, the court requests a final explanation of the law on the point at issue from the legislature.

The institution of the Court of Cassation has proved highly beneficial to France; it has acted as a watchful guardian of the laws; it has afforded protection to the citizens against the arbitrary acts, and the misjudgments or misconstructions of the other judicial courts of the country. Placed by the nature of its office out of the immediate influence of political passions, it has maintained its high character for strict impartiality throughout all the changes of government and administration. Many of the most distinguished jurists of France are numbered among its members. We can only mention here the names of Henrion de Pansey, who was long president, and is known for his juridical works; and Merlin de Douai, who was procureur to the court, and is the author of the 'Répertoire de Jurisprudence,' 16 vols. 4to. See an able article on the Cour de Cassation in the 'Encyclopédie de Droit' (vol. vii.), by Monsieur Delangle.

CASSIN. A bitter principle of unknown composition contained in cassia.

CASSIOPEIA. This constellation is called Cassiepeia (*κασσιέπεια*) by Aratus, and Cassiopea by Manilius. In the Greek fable, Cassiopeia is the wife of Cepheus and mother of Andromeda, placed in the heavens with her head from the pole, so as to turn round apparently upside down, because (according to Hyginus) she boasted of her own beauty as superior to that of the Nereids. This constellation may be found by looking on the side of the pole opposite to the Great Bear, where will be seen five rather bright stars disposed in something like an M. These stars are also in a line drawn from Capella to the bright star in Cygnus, and about half way between them. The old figure is that of a woman sitting in a chair or throne, with a branch in her hand. The constellation is on the meridian at midnight, about the end of September, and at eight P.M. about the end of November. The remarkable star which appeared in this constellation in 1572 has been noticed in TYCHO BRAHÉ, in the BIOGRAPHICAL DIVISION, who also affirms that similar stars appeared in 945 and 1264, whence Sir J. Herschel thinks it possible another such appearance may take place in 1872. But the authority for the first appearance is that of a contemporary of Tycho Brahé, from nameless manuscripts, and as comets are recorded in or about both 945 and 1264, these may have been the stars spoken of. See the 'Companion to the Maps of the Stars, of the Society for the Diffusion of Useful Knowledge.' Baldwin, 1836, p. 86.

The following are the principal stars in this constellation:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
β	11	7	2·5
κ	15	126	4
ζ	17	153	4
α	18	169	3
η	24	218	4
γ	27	253	3
θ	33	339	4·5
δ	37	416	3
ϵ	45	564	3

CASTANETS, a musical instrument of percussion, of Moorish origin, composed of two small concave pieces of chestnut wood (hence the name) or of ivory, in the form of cockle-shells, united at one end by a string, hung on the forefinger and thumb, and struck together in musical time, while the performer is dancing.

CASTES. [HINDOOS, CASTES OF].

CASTIN. A substance hitherto imperfectly examined, contained in the fruit of the *vitex Agnus castus*.

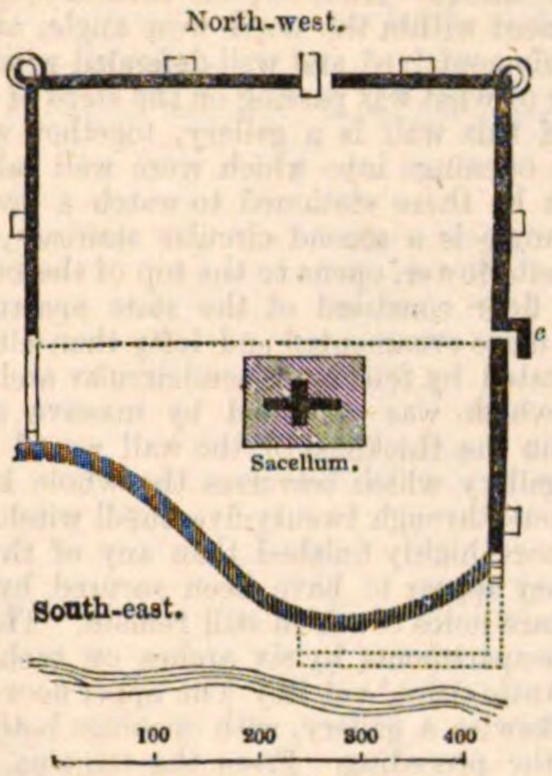
CASTING. It is desirable to point out under what headings the reader will find descriptions of those processes which are known by the common name of *Casting*. This operation is generally understood to mean, the pouring of a metal or some other substance, while in a fluid or semi-fluid state, into a mould. The fluidity may be caused by heat or by some other agent, but the cast, or moulded article, always solidifies in the mould. The manufacture of great iron castings is described under FOUNDING; that of bells under BELL; that of metal statues under BRONZE; that of plaster statues under SCULPTURE; that of artillery under CANNON; that of ornamental earthenware, or china-ware (where the material is poured in a liquid state *into* a mould, instead of being pressed in a dough-like state *on* a mould), under POTTERY and PORCELAIN. Various other applications are incidentally noticed under BUTTON, COPPER, LEAD, STEEL, &c. We will simply notice in this place a remarkable patented invention in casting, not because it applies to any one department of industry, but because it seems to have a useful applicability to many kinds. It was patented a few years ago by Mr. Fairbairn, and relates not so much to the casting in moulds, as to the making of the moulds themselves. The article or model of which a mould is to be made is to be cut in half in the direction of its widest plane. The two parts are then attached to opposite sides of a plate or diaphragm. Two half-moulds are successively made from these two parts, and are fitted accurately together when regular castings are to be taken from the mould. It is considered that time and labour may be economised by this means, by attaching two or more articles to the opposite sides of the diaphragm, and then forming suitable channels for the flow of the molten metal. For *under-cut* articles, those parts require to be loosely attached, so as to be raised with the sand-mould.

CASTLE, from the Latin *castellum*, a diminutive of *castrum*, an encampment, is a walled inclosure with a tower or towers, strongly constructed and intended as a place of safety. Numerous castles, for the most part in ruins, still remain in various parts of Great Britain, France, Germany, Italy, and in the East; but our remarks will be principally confined to those of this country. The castles of England consist almost entirely of those erected after the Norman Conquest; but there are a few fragments of Roman date, and some portions erected prior to the Norman invasion.

In various parts of England, Scotland, Ireland, and Wales, there are numerous encampments or castles, mostly occupying the summits of hills, which have been ascribed to the aboriginal inhabitants. Among the most remarkable are the Herefordshire Beacon, on the Malvern Hills, in Worcestershire; the Caer-Caradock, near Church Stretton, in Shropshire; Moel Arthur, in Flintshire; Chun Castle, in Cornwall; and Maiden Castle, in Dorsetshire. (Britton's 'Arch. Dict.')

Roman Castra were probably sometimes formed on the sites of British works. Richborough Castle, in Kent, perhaps the earliest Roman castle constructed in this island, has been conjectured to have been formed in the reign of Claudius, and completed by Severus (Batteley's 'Antiq. Rutupinæ,' pp. 6, 14, &c.), but this is mere conjecture. The leading features of a stationary castle or encampment built by the Romans still remain. The basement of the Sacellum, or small temple for depositing the ensigns, forms an important feature in this castle; and in the walls some antiquaries believe they can find traces of the four gates. King ('Munimenta Antiqua,' vol. ii. p. 10) gives a plan and full particulars, made out when the ruins were in a

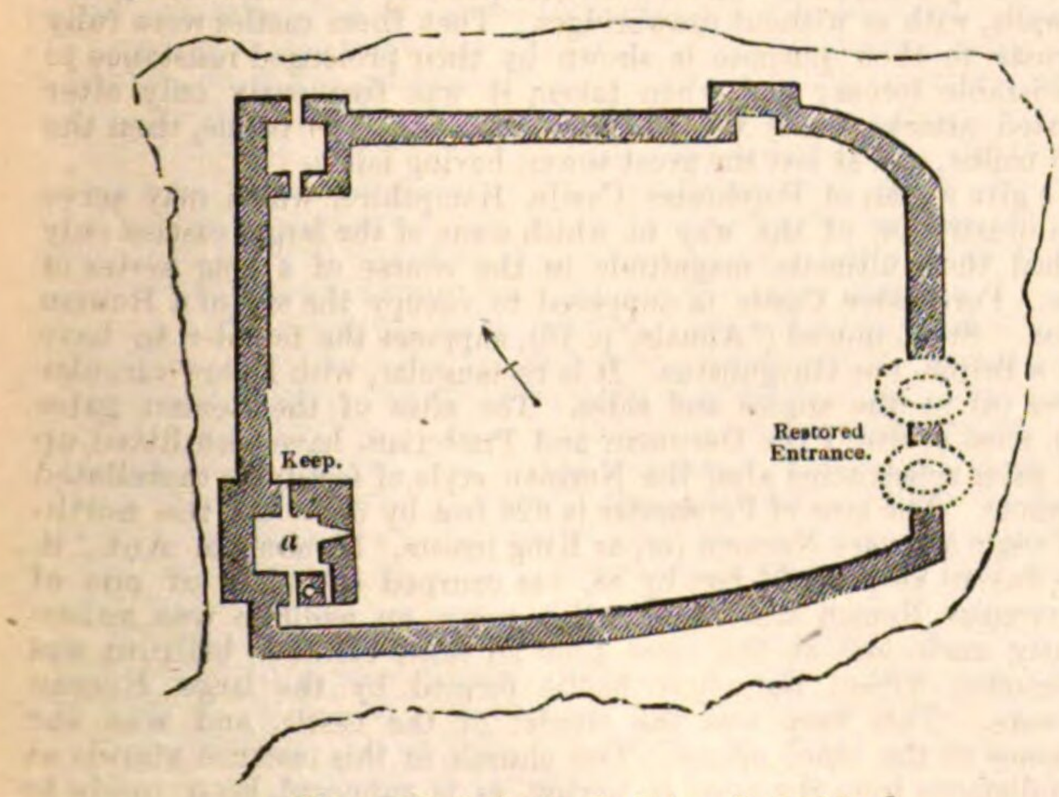
much more perfect state than they now are. According to this plan, the entrance through the north-east wall is by one of the two gates (*c*)



[Plan of Richborough Castle.]

called by the Romans the Porta Principalis, and which became in after-times the postern gate. The Prætorian gate he supposes to have been on the side of the slope towards the æstuary, which formerly bounded this side of the castle. The second principal gate was opposite the first principal gate or postern; and the Decuman gate and the Prætorian are presumed to have been nearly opposite. The form of this castle, like Burgh, is nearly a rectangular parallelogram, with rows of bricks placed at intervals in the walls in a horizontal position. These layers of bricks formed a fresh foundation for every succeeding layer.

Saxon castle-building was probably borrowed from the Romanised Britons, who had acquired a taste and knowledge of the arts from the Romans. Thus, in Pevensey, there are works that have an appearance of Roman character and design, and yet are so much ruder in execution than any other Roman works, that they can only be referred to a time when the knowledge of the Roman arts, though yet fresh in the memory of the inhabitants, might probably be on the decline. But the remains of castles which can with any approach to certainty be termed Saxon are few and of little consequence. King, the great authority with the past generation of antiquaries, wrote a work (the 'Munimenta Antiqua') full of learning and ingenuity, but sadly wanting in judgment, and abounding in fanciful conclusions and false inferences, in which he lays down very decidedly the distinctions between Norman and pre-Norman castles, and gives plans and descriptions of many of Saxon as well as of Norman date. Among many others, King considers Peak Castle, Castleton, Derbyshire, to be a genuine Saxon castle, from the style of its architecture and the appearance of herring-bone masonry in the walls; but what he regards as Saxon work probably belonged to an earlier building, and there is little reason to suppose that the castle, as it at present appears, is of an earlier date than the first half of the 12th century. We give his plan as an example of one of these so-called Saxon castles.



[Plan of Peak Castle, Castleton, Derbyshire.]

The keep (*a*) is attached to the walls of the castle, which is also fortified with one small square tower and another half tower. The

attachment of the keep-tower to the walls of the castle is regarded by writers of this school as a characteristic of the Saxon castle. The length is about 200 feet by a varying width extending to about 150 feet.

King also gives some plans and views of English castles which he thinks may have been constructed after the plan of Syrian castles, to which he argues they bear, in many parts of their plan, a strong resemblance. Launceston, Brunless, and others are mentioned by him as being of Phœnician origin, a position which it is much easier to assert than to prove. Conisborough, another singular castle, is considered by the same author to be an early British work: it is beyond doubt Norman.

There were no doubt fortresses of some strength existing in England when under the Saxon rule, but the little resistance they opposed to the progress of the Conqueror is a proof that they were neither numerous nor of much importance; and it is certain that nearly all the castles now remaining, whether entire or in ruins, date from a period subsequent to that of the Norman invasion. It would seem indeed, according to Asser's statement, that Alfred built castles of wood and stone, and Henry of Huntingdon states that Elfrida, his daughter, built eight castles in three years. William of Malmesbury describes a stone castle built by Athelstan at Exeter in 944. William the Conqueror was a great builder of castles. The 'Reports' of the Records Commissioners mention thirty castles known to have been built during his reign; and he gave the custody of his crown castles to the most powerful and trusty of his Norman followers, as constables or castellans. Forty-nine castles are mentioned in Domesday Book, which notices Arundel as the only one named in the time of the Confessor. The sons of the Conqueror largely increased the number of castles; and according to Ralph de Diceto in the nineteen years of Stephen's reign 1115 castles were erected. But these were strictly feudal castles, the property and under the virtually uncontrolled authority of the territorial nobility. The 'Saxon Chronicle' speaking of this castle-building time, uses very emphatic language,—"Every rich man built his castles and defended them, and they filled the land full of castles. And they greatly oppressed the wretched people by making them work at these castles; and when the castles were finished, they filled them with devils and evil men." The practice, however, soon became as inconvenient to the sovereign as to the common people. Henry II. made it unlawful to erect a castle or to fortify (battellare et kirnellare) a residence: and Henry, at least, seldom granted such a licence. It is almost unnecessary to remark that the building of such strong edifices, which in the then state of warfare were often impregnable, is a proof of the insecurity to life and property which prevailed. Every feudal chieftain had his stronghold, round which his immediate retainers rallied for the purpose of mutual defence, or to annoy and plunder their neighbours. A very considerable number of old towns of Europe gradually rose around these baronial fortifications, and it is interesting to trace, in the history of many of these communities, the progress by which the town, originally a miserable dependence on the castle, gradually obtained privileges, and charters, and wealth; and increased in strength and importance exactly in proportion as the owner of the fortress lost both; till finally the castle, from being neglected and deserted, was either levelled with the ground and furnished materials for house-building, or remained in ruins, an enduring monument of the slow but certain victory of the once subject townsmen over their lords.

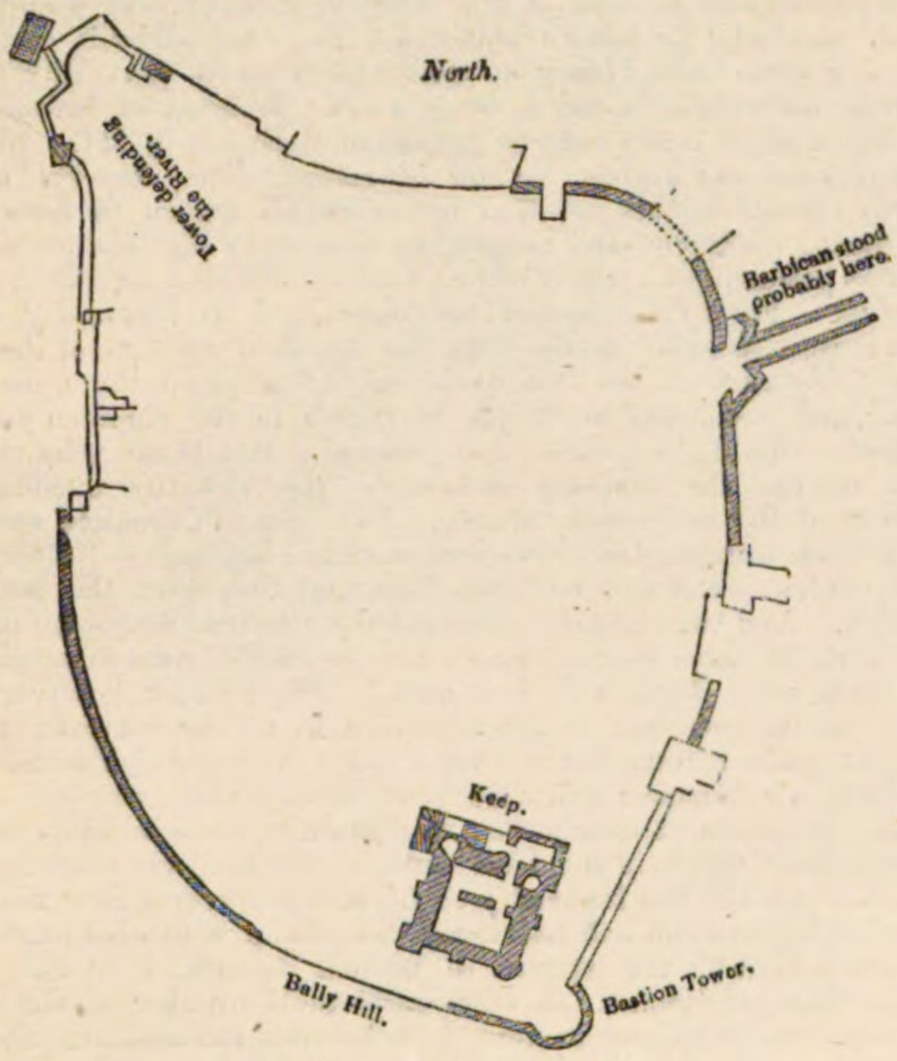
The Norman castle in its earliest and simplest form consisted in its main features of a keep or stronghold, a base-court, the outer walls or curtain, a gate-house, and a fosse or ditch—except where the natural strength of the position rendered that defence unnecessary.

The keep was the grand feature, the centre and basis of the castle; and it appears to have been derived directly from the strong tower of the Roman walled castle, or permanent station, as that corresponded to the pretorium of the usual encampment. [Camp, Roman.] Usually the Norman keep was square or oblong, built of the ordinary rubble-stone of the neighbourhood, and faced, or only dressed and groined, with ashlar, and having the usual flat pilaster-like Norman buttress. [Buttress.] The walls at the base varied, according to the size of the tower and the importance of the station, from 12 to upwards of 20 feet in thickness; and diminishing to 8 or 10 feet at the summit, which was crowned by a battlement of more than a foot in thickness. Their strength consequently, if measured against the military implements then in use was enormous. Nor were the few polygonal keeps of the early Norman period less strong than the square ones. Indeed, an eminent civil engineer says of that of Conisborough castle (about six miles from Doncaster, supposed to have been erected by William de Warren about 1070), that "Vauban himself could not have contrived a tower capable of greater resistance." (Cresy, 'Encyc. of Civil Engineering.') In the walls, staircases and chambers, with connecting galleries, were hollowed out at different heights, but they were usually of small size, and only lighted by loops in the lower stories: the upper rooms had the ordinary Norman window. The entrance was generally on the first floor, and reached by an open, narrow, and easily defended staircase; or the staircase was enclosed in a small turret. As examples of these square towers we may refer to those of Newcastle, Rochester, Guildford, &c. Sometimes as at Conisborough, Richmond, Castleton, &c., the keep formed a part of the outer walls, but it was usually placed entirely within the walls, in the strongest and most defensible position, it being intended as the last resort in case of the outworks

being stormed or taken. Sometimes the keep was built on an artificial mound, but sometimes there was a mound, with or without a donjon, in addition to the keep.

The base-court contained the lodgings of the garrison, the store-houses, and various offices. The surrounding walls were from 20 to 25 feet high; occasionally strengthened with towers or bastions; and had a terrace walk with a parapet. The gatehouse was of great strength, flanked with towers, and sometimes perhaps, though not often, in the earlier castles, defended by a barbacan. [BARBACAN.] From the gatehouse, a drawbridge was let down across the fosse, which was sometimes a dry, sometimes a wet ditch.

Rochester castle, which stands on a small eminence near the bridge over the Medway, is a fine example of a Norman castle of this period. It was probably rebuilt by the Normans, soon after the conquest, on the site of a more ancient castle.



[Rochester Castle and Keep.]

The keep, "which originally consisted of four floors, including the basement or dungeon story, is about 70 feet square at the base, with walls varying from 13 to 8 feet in thickness, and rising to the height of 105 feet to the top of one of the angular turrets. The walls of the ground-floor slope or bend inwards; but from that to the top they are continued perpendicularly. Externally there is a pilaster buttress near the centre of each side, and at three angles are square staircase turrets, and a rounded turret at the fourth angle. At the north face is a projecting work, forming a sort of vestibule to the chief entrance door-way to the first floor, and this is approached by a flight of steps commencing at the western side, and returning round the corner. The walls, doors, and windows are constructed to repel assailants.

"The first ascent was by a flight of twelve or thirteen steps, leading round the north-west angle to an arched door-way, beneath which a flight of seven steps led forward to a draw-bridge that connected with the arched gateway to the entrance-tower: this opened into the vestibule, between which and the keep there were no other avenues of communication than by a third arched passage in the thickness of the wall. This latter inlet to the body of the keep was defended by a massive door and portcullis, the hinges and grooves of which remain; and in the roof are openings for the purpose of showering missiles on the heads of assailants."

The interior of the keep is divided longitudinally by a strong wall into nearly equal parts, which communicate by open arches on each floor. In the centre of this wall is a well of considerable depth, 2 feet 9 inches in diameter, neatly wrought, open to the very top of the keep, and communicating with every story. There were three stone floors besides the basement. "The basement story was low and gloomy; here the munition and stores for the use of the garrison were deposited. In the north-east angle is a circular winding staircase, communicating from the ground to the summit, and within the south wall is a square passage, or funnel, which also communicates with the upper floors, and from its singularity has given rise to much fanciful speculation; among other conjectures, it has been considered to have been used for the conveyance of stores to the upper part of the keep." On the north side is a flight of steps leading to what is known as the dungeon.

"The first floor, which seems to have been that occupied by the soldiery, and into which was an entrance from without, was 22 feet in height. Besides seven large loop-holes, larger than those beneath, there were two spacious conical fire-places, the flues of which gradually contracted to the outer part of the walls, where there were small apertures for the smoke. Another, but smaller fireplace is contained in a little apartment within the north-west angle, and here also were two very curiously-contrived and well-defended windows, designed to command a view of what was passing on the steps of entrance. Within the east floor of this wall is a gallery, together with some private apartments, the openings into which were well calculated to secure those who might be there stationed to watch a besieging army. In the south-east angle is a second circular staircase, which, as well as that in the opposite tower, opens to the top of the building.

"The second floor consisted of the state apartments, 28 feet in height, and was more ornamented and lofty than either of the others. These communicated by four large semicircular arches, formed in the partition wall, which was sustained by massive columns and half columns. Within the thickness of the wall round the upper part of this floor is a gallery which traverses the whole keep, and receives light from without through twenty-five small windows: the exteriors of these were more highly finished than any of the lower openings, and inwardly they appear to have been secured by wooden shutters, the hinges and bare holes of which still remain. This gallery was also open to the state-apartments by six arches on each side." (Britton's 'Architectural Antiquities,' vol. iii.) The upper floor was about 16 feet high, and has likewise a gallery, with openings both within and without, similar to the preceding. From the remains of a large arch in the south-east corner it seems probable that the chapel was placed here.

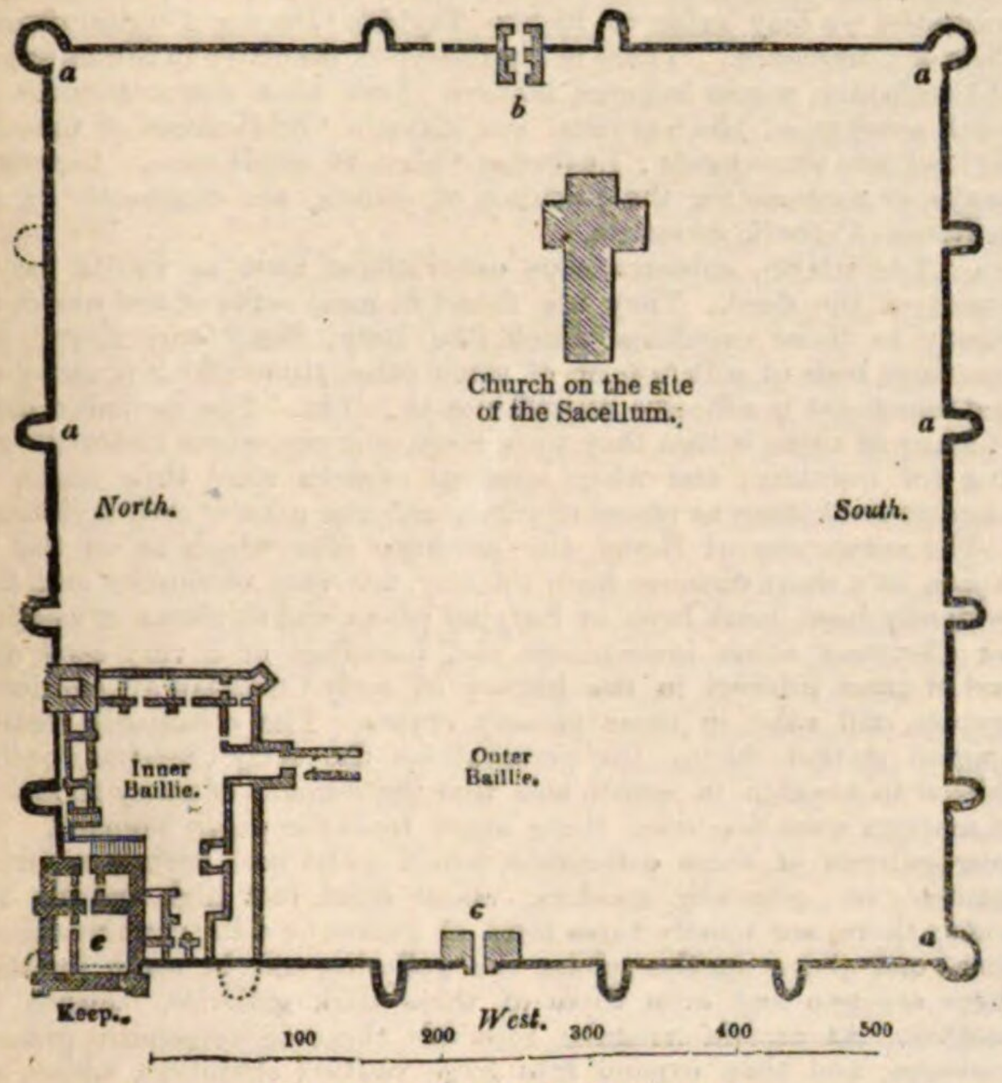
The roof of the keep, as well as the floors, have been destroyed: the former, probably, consisted of a platform on a level with the top of the wall within the parapet: the latter was about 5 feet high, and had embrasures about 2 feet wide. The four towers at the angles were raised another story, and had also small platforms with parapets and embrasures. The gutters which conveyed the water from the platform still remain.

The outward walls, which formed an irregular parallelogram of about 300 feet in length, were strengthened by several square and round towers embrasured and provided with loopholes and machicolations. On the north-east was the principal entrance, which was defended by a tower gateway with outworks at the sides.

The later Norman castles, of which those of the time of Edward I. may be regarded as the most perfect examples, covered a much more extensive area, were much more complex and elaborate in plan and more ornamental in design, and presented many of them a magnificent appearance. Such were, among others, those of Windsor, Conway, Caernarvon, Cardiff, Chepstow, Kenilworth, Warwick, Hedingham, Porchester, and many more. The keep was of statelier proportions, sometimes assuming the character of an open quadrangle or inner baillie, defended by gate-houses and flanked by towers. The base-court was divided into two parts, sometimes into three,—the outer baillie, in which were the stables, and sometimes a mound, or small cavalier; the middle baillie, containing the servants' apartments and domestic offices; and the inner baillie (which formed the keep), around which were concentric lines of defence, and in which were the hall and the chapel, often a very handsome building. The outer walls had embrasures, and were strengthened by turrets, sometimes of the kind called bastions, and towers, occasionally of large size, and either round, square, or multangular, as the Beauchamp Tower, Warwick Castle. The gate-houses were distinct works, with large drum or circular towers, as at Chepstow, Beaumaris, &c.; the entrances were machicolated, had portcullises, were nearly always approached by drawbridges, and often defended by barbicans. There were also posterns or small doorways in the walls, with or without drawbridges. That these castles were fully adequate to their purpose is shown by their prolonged resistance to considerable forces; and when taken, it was frequently only after repeated attacks,—first the barbican, then the outer baillie, then the inner baillie, and at last the great tower, having fallen.

We give a plan of Porchester Castle, Hampshire, which may serve as an illustration of the way in which some of the larger castles only reached their ultimate magnitude in the course of a long series of years. Porchester Castle is supposed to occupy the site of a Roman station. Stow, indeed ('Annals,' p. 12), supposes the founder to have been a Briton, one Gurgunstus. It is rectangular, with hollow circular towers (*a*) at the angles and sides. The sites of the Roman gates (*b*, *c*), most probably the Decuman and Prætorian, have been fitted up with gates constructed after the Norman style of fortifying castellated entrances. The area of Porchester is 620 feet by 610. At the north-west angle a square Norman (or, as King insists, 'Munimenta Ant.,' ii. 28, a Saxon) keep (*e*), 57 feet by 58, has usurped the place of one of the circular Roman towers. To this tower an addition was subsequently made, and at the same time an inner baillie or ballium was constructed within the outer baillie formed by the large Roman inclosure. This keep was the citadel of the castle, and was the residence of the chief officer. The church in this instance stands at some distance from the keep, it having, as is supposed, been made to occupy the site of the Roman sacellum. Close to the Prætorian gate it is still in good preservation. At Caistor, in Norfolk, the church also occupies the site of what was probably the ancient temple. The keep at Porchester stands upon the outward wall of the castle area

itself. The *Themelii* (Θεμέλιοι, layers of bricks) are seen in parts of the Roman walls, which, like all the walls of Roman castra, are of rubble; while the Norman works are usually faced with squared stones. Pevensey Castle, in Sussex, is also considered to be in part a late



[Plan of Porchester Castle, Hants.]

Roman work, if not an Anglo-Roman building. The *Themelii* are not laid horizontally, as at Richborough and Burgh, but more like the Saxon herring-bone. Like Porchester, it has had many subsequent additions in later times. The earlier works are far more durable than the later constructions. The plan is an irregular curve with solid towers, and a curved inner ballium with hollow towers, and a keep. The plan given in King's 'Munimenta' is very incorrect, having nearly the form of a circle, while the real shape approaches to that of a triangle with the ends round. The walls at Pevensey average 10 feet in thickness and 20 feet in height.

The Norman castle formed before the invention of gunpowder an almost impregnable stronghold; but it was at best a gloomy and uncomfortable abode. When the triumphs of Edward III. secured internal as well as external peace and security, and the arts of peace began to be cultivated, the want was felt of dwellings of a more domestic character, and better fitted for the growing splendour of private life. To the castles, halls and apartments of a more luxurious character were added, and various alterations were made. But another class of abode began to be erected, midway in character between the stern feudal castle of the past and the stately mansion of a future generation. These were the Castellated Mansions, in which, while comfort and even elegance were sought after, security was not neglected. Something of the appearance as well as the name of a castle was retained, but little of its dreariness. It was thought sufficient if, by means of its moat and drawbridge, its strong towers and pierced turrets, its treble portcullised doors, and its thick embattled walls, it could withstand the casual attack of a marauding band, though it might not be capable of enduring a regular siege. Of this class and time is Hever Castle, Kent, erected by William de Hever, lord of the manor, who obtained a licence from Edward III. to erect his manor-house at Hever "more castelli." The building is a quadrangle inclosing a court-yard, and is surrounded by a moat. The principal front consists of the great entrance gateway, which is a large and lofty stone structure, flanked by two square towers. Answering in some measure to the Norman keep, this part was made of great strength. The approach was by a drawbridge (now replaced by a fixed wooden bridge). Over the gateway impend bold machicolations. The towers are not only embattled, but pierced with oilets and loopholes. Within the gateway are three strong doors, one behind each other, and each defended by a portcullis; and in the gate-house were guard-rooms, fitted with all necessary appliances.

The progress may easily be traced from buildings of this kind to the purely domestic palatial mansions of recent years, through the beautiful "halls" and "castles" still embattled and built with considerable show of strength, and, indeed, as was proved by some of them in the civil-war of the reign of Charles I., capable of resisting a considerable force for some time, but really constructed as private dwelling-houses. As examples of this kind may be cited, Aydon Castle, Northumberland; Penshurst, Kent; Ludlow Castle, Shropshire; Oxburgh Hall, Norfolk; and many others, till as we descend,

every feature of a defensive kind disappears. To trace this progress, however, does not fall within the province of the present article. The last stage of the "castle" proper, is perhaps marked by brick buildings like Herstmonceaux Castle, near Pevensey, Sussex, which is of brick, and perhaps the oldest existing edifice constructed of brick after the re-introduction of that material. It was built in 1440 by Sir Roger de Fiennes, treasurer to Henry VI., pursuant to a licence obtained from that monarch "to embattle and fortify his manor-house at Herstmonceaux." The castle is much on the plan of that at Hever. It is square in plan, the sides being 214 feet, the front 206, and it is surrounded with a moat. The front consists of a grand central gate-house, with machicolated towers on each side of the gateway, over which are machicolations, and within were portcullises. At the angles, and also at the sides, are lofty embattled towers. Another of these brick castles is Tattershall, in Lincolnshire, erected about 1455, which consists of a large square brick tower, with polygonal turrets at the angles. Others occur at Thornbury, Caistor, and elsewhere. Thornbury, begun in 1540, and Longford erected in 1591, were the last mansions erected in England with any pretence to a military character prior to the imitative castles of the last and present centuries.

Mr. G. T. Clark, in a very able paper on Castles, in vol. i. of the 'Archæological Journal,' states the number of castles which are known to exist, either perfect or in ruins, in the United Kingdom, to be, in England, 461; Wales, 107; Scotland, 155: Ireland, 120; in all 843; but it is very difficult to obtain a complete list, and he is no doubt within the mark in saying that the true number is probably near 1000.

Few parts of Europe contain so many ruins of castles as the banks of the Rhine. They are almost all built on an irregular plan, and adapted to the nature of the rugged sites on which they are placed. The most remarkable both for their size and history are the castles of Ehrenbreitstein and Heidelberg.

There are very many ruins of fine castles in Normandy and in the Pays des Vosges. Switzerland has also its castles, but they are on a smaller scale. The French castles were occasionally bastilles, like Villebon, the castle of the Duc de Sully.

For further information on castles the reader is referred to Britton's 'Architectural Antiquities,' Dallaway's account of castles in his 'Discourse on Architecture in England;' 'Ancient Castles of England and Wales,' engraved by W. Woolnoth, with descriptions by E. W. Brayley, jun.; Mr. Clarke's paper on Castles in the 'Archæological Journal,' already referred to; the article Castle in the 'Dictionary of the Architectural Publication Society;' Billing's 'Baronial Antiquities of Scotland;' and (making allowance for the erroneous theory upon which it goes, and consequently distrusting the so-called "restorations") King's 'Munimenta Antiqua;' also the drawings and prints of castles in the king's library of the British Museum; and notices of castles in the 'Archæologia,' the 'Gentleman's Magazine,' and the 'Archæological Journal,' and 'Journal of the Archæological Association.' On the Castles of France, and the student must remember they are the prototypes of the castles of England, a most careful account will be found in the 'Dictionnaire' of M. Viollet le Duc, article Chateau; and very full and valuable accounts in M. de Caumont's 'Cours d'Antiquités,' vol. v., and 'Architecture Civile et Militaire,' p. 261 to the end.

CASTOR, or α Geminorum, one of the bright stars in the head of the twins from which the constellation gets its name, being the nearer of the two to the pole. [GEMINI.] This is a remarkable double star; that is to say, consists of two stars so close together as to be inseparable to the naked eye, which are nearly equal, and compose the appearance of the third magnitude. The two are, however, easily separated by a moderately good telescope. Sir J. Herschel has determined the elements of the orbit in which each star moves round the other. ('Mem. R. Astron. Soc.,' v. p. 196.) He calls the star "the largest and finest of all the double stars in our hemisphere, and that whose unequivocal angular motion first impressed on my father's mind a full conviction of the reality of his long-cherished views on the subject of the binary stars." By observations of Bradley and Pound, Maskelyne, W. Herschel, Professor Struve, his own, and Sir J. South, he has deduced the following elements of the elliptic orbit of each star round the other; major semiaxis, 8·086"; eccentricity, ·7582; inclination of the real orbit to the apparent orbit on the sphere of the heavens, 70° 3′; position of node, 58° 6′; perihelion measured from node on orbit, 97° 29′; period of revolution, 253 years; the last period of closest approach was 1855.

CASTOR FIBER (Linn.), the Beaver. Into a cavity situated at the posterior part of the trunk, both in the male and female animal, the urinary organs and anus open, and in this are also lodged two pear-shaped bags, which receive the secretion of certain glands, which is termed castor. The bags are united by a ligament supposed to be their excretory duct. The secretion is at first in a liquid state about the consistence of syrup, but it ultimately becomes solid, losing some of its odour and activity. As met with in commerce it is of two kinds, the Russian and American. The American is of two sorts, both imported by the Hudson's Bay Company, yet one is called the Hudson's Bay castoreum, the other is called Canadian; the first is the best. The Russian is the rarest and most esteemed; it is more carefully managed from the time of its excision, being first dried in smoke, and often wrapped in swine's bladder. The bags of Russian castor are in pairs of unequal size, from 3 to 4 inches long, and 1½ to 2 inches

broad towards the base; the skin thick, smooth, of a brownish red or yellow, the mass more or less friable or tenacious according to age; adhering to them are in general the remains of the oil or fat bags. The odour is peculiar, very penetrating, and unpleasant; the taste is also peculiar, bitterish, somewhat acrid or aromatic, and enduring. The bags of American castor are smaller, narrower at the base, of a great variety of colours, yellow or orange-brown or brownish-black, the skin thinner, more of the consistence of paper, the surface often wrinkled, and in general no vestiges of the oil-bags present. Both kinds are occasionally slit open and a part of their contents abstracted. A seam on the surface and an internal cavity, sometimes filled with other materials, indicate when this fraud has been effected.

Castor should be kept in a cool place, in a well-corked bottle.

Brandes, from 1000 parts of Canadian castor, obtained :—

Volatile oil	10·0
Castorine pure	7·0
Castorine with carbonate, urate, and benzoate of lime	3·5
Castoreum-resinoid	120·0
Castoreum-resinoid with benzoate and urate of lime	16·0
Castoreum-resinoid obtained by ether	1·0
Castoreum-resinoid from watery extract	1·5
Albumen with trace of phosphate of lime	0·5
Osmazome-like matter	2·0
Phosphate of lime	14·0
Carbonate of lime	336·0
Carbonate of magnesia	4·0
Sulphate of potassa, sulphate and phosphate of lime	2·0
Animal mucus	23·0
Carbonate of ammonia	8·2
Animal matter	23·0
Skin and salts	192·0
Loss and moisture	229·1

Occasionally *carbolic acid* and *salicine* are found in Canadium castoreum. The latter is derived from the willows on which the beaver feeds. Russian castoreum has far more volatile oil and resin.

Castorine is also called *Castoreum camphor*. It may be obtained by boiling one part of castor in six of alcohol, and leaving the filtered liquid to cool, when it falls to the bottom. It is very combustible, and is neither acid nor alkaline; it has a copperish taste. It crystallises in long diaphanous fasciculated prisms, is insoluble in cold water and cold alcohol, but dissolves in 100 parts of boiling alcohol, also in the volatile oils. Bizio considers it the active principle of castor, but it is more probable that the active properties depend upon the essential oil and resinoid principle: the most proper menstruum to take up these is alcohol or the ethers. Rectified spirit is preferable to proof spirit to form the tincture. The compound tincture of the Edinburgh Pharmacopœia is a valuable form of exhibition. It should never be prepared as an extract or a decoction. The powder is not an objectionable form, if too high a temperature be not employed to dry and render it friable.

If from five to ten grains of castor be received into the stomach, a gentle heat is felt in that organ; a more considerable dose causes a still greater sense of heat, and increased strength and frequency of pulse. That the principles of castor pass into the blood is proved by the secretions acquiring its odour during the employment of it internally. It appears to act specially on the cerebro-spinal and ganglionic systems of nerves, so as to modify their condition. Hence it is used against spasmodic symptoms, and to restore the healthy action of the nervous system when that is disturbed. It is rarely given to excite the digestive organs, the heart, or the lungs, but chiefly to influence the brain, the spinal cord, and the uterus. Its employment is sometimes followed by very profound sleep, which, if the dose be moderate, need not excite alarm. Castor is most useful in hysteria, hypochondriasis, nervous palpitations of the heart, convulsive hiccup, colic, and similar diseases. It ought not to be employed if any morbid sensibility of the stomach or enlargement of the heart exist.

CASTOR OIL. [Croton.]

CASTORIC ACID. [Castorin.]

CASTORIN. A white, crystalline, fatty substance contained in the secretion of the beaver, known in pharmacy as *castoreum*. By long boiling with nitric acid it is converted into *castoric acid*. Neither of these substances has been analysed. Castorin appears to be allied to *cholesterin*.

CASUISTRY, the name of a science which professes to give rules for the resolution of doubts of conscience. It was greatly cultivated in the 15th and 16th centuries, especially by the Jesuits, and was calculated to be a very efficient instrument of the crafty policy ascribed to that order. For the confessor, who professed himself able to lay down exact rules of conduct, to weigh the merits of two conflicting duties, and decide which was the greater of two sins, had the means of obtaining an almost boundless influence over his penitent. But casuistry under some form, and more or less elaborated, must be studied wherever confession, penitence, and absolution under the guidance of the priesthood are doctrines of a church, and where consequently the younger, more inexperienced, or less learned priests, require authoritative direction in difficult cases. The science of casuistry, however, though so liable to abuse that it has been termed, not inaptly, the "art of quibbling with God," has been cultivated in the reformed as well as the papal church, and for a specimen of its subtleties we may refer to Bishop Taylor's 'Ductor Dubitantium, or Rule of Conscience.' There is a professor of casuistry in the university of Cambridge, whose lectures, however, have been discontinued. For a full account of the casuists, see Mayer's 'Bibliotheca of Casuists,' divided into three heads: Lutheran, Calvinist, and Roman. Casuistical works, or manuals for the guidance of priests, are constantly on sale in Roman Catholic countries.

CATACOMBS, subterraneous excavations, used as vaults for the burial of the dead. They are found in most parts of the world, but chiefly in those countries which, like Italy, Sicily, and Egypt, offer extensive beds of soft *tufo* or of some other stone which is easily cut, and which yet is adhesive enough not to fall in. The probable origin of many of them is that they were mere quarries, where materials were dug for building; and when spacious caverns were thus made, the adaptation of them as places of interment was natural and obvious.

The catacombs of Rome, the entrance into which is on the Via Appia, at a short distance from the city, are very extensive, and have evidently been used both as burying places and as places of worship; for Christian altars, inscriptions, and paintings, of a very early date, and of great interest in the history of early Christian art and iconography, still exist in these gloomy crypts. The commonly received opinion is, that during the persecutions the early Christians retired thither to worship in secret, and that the remains of many thousands of martyrs were deposited there apart from the pagan Romans. The long galleries of these catacombs, which twist and turn in a curious manner, are, generally speaking, about eight feet high and five feet wide; there are mostly three tiers of graves or cells, running lengthwise, one above another, along the galleries, and in some instances there are two and even three of these dark galleries, beneath one another. At certain irregular intervals these subterranean passages converge, and then expand into large vaulted chambers, which still look like churches. The more regular chapels met with in many of them are the works of a later age, some of them having been formed by order of the popes, and executed with great care. Although the cross and the monogram of Christ have long been affixed to every accessible corner, and the traditions of the Romish church give the exclusive occupancy of the catacombs to the Christian dead, there seems good ground to believe that the ancient and pagan Romans deposited their dead in them. According to the ciceroni, or guides, taking in their different ramifications, these cold gloomy galleries run for twenty miles under ground, and several recent travellers have stated their length at six miles, confessing, however, that from their having fallen in and become dangerous in many parts it is not possible to penetrate them to anything like that extent. Agincourt, 'History of Art by its Monuments,' has, in Vol. I. plates ix.–xiii., collected together plans, sections, views, and illustrations of the contents of "The most celebrated Catacombs, Pagan and Christian."

The catacombs of Naples, which are cut in tufo under the hill called Capo di Monte, do not differ materially from those of Rome, except that the main streets are much wider; and their real extent, which is considerable, is liable to the same exaggeration. The entrance into them is rendered horrible by a vast heap of skulls and bones, the remains of the victims of a plague which desolated Naples in the 16th century. Some of these passages are almost covered with Christian symbols, and the paintings in one of the large vaulted chambers or churches, though badly drawn, have retained a wonderful freshness of colouring, considering their underground damp situation. The spreading palm-tree is a frequent feature in these pictures. On the site of the ancient Etruscan city, Tarquinia, about three miles from the small modern town of Corneto, catacombs of immense extent have been opened within the last century and a half. They were excavated in the white calcareous stone of which the hill is formed on which the ancient city stood, and they must have been in use at the best time of Etruscan art, as the walls are decorated with fresco paintings of figures; friezes executed with great skill and spirit, and vases of admirable form and decoration, mosaics, arms, &c., have been found in them. (D'Agincourt; Inghirami, 'Monumenti Etruschi;' and Von Stackelberg, 'Aelteste Denkmäler der Malerei, oder Wandgemälde aus den Hypogäen von Tarquinii.') At Palermo and at Syracuse there are similar recesses; the catacombs of the latter place being very considerable, and laid out with great regularity, while close in the neighbourhood there are plenty of quarries and subterranean excavations that might have been turned to the same uses. These catacombs form extensive streets of tombs with circular halls, far more regular in plan than the catacombs of Rome; and in their case it is evident that they were originally used by the pagan population, and subsequently by the Christians, as they are filled with Greek and Roman as well as Christian and Saracenic tombs. The entrance to these catacombs is under the small church of San Giovanni, in the lower part of Acradina. In the island of Malta, catacombs of a much more limited extent are found at Città Vecchia, cut into the rock on which that old town stands. They occur again in the Greek islands of the Archipelago. At Milo (one of the Cyclades) we have seen a mountain completely honeycombed with

them, a labyrinth of tombs running through it in all directions. From the *bassi-rilievi*, figures in terra cotta, and other works of art found in them, it was evident that these tombs were of a date far anterior to the Christian epoch.

In Egypt these subterraneous excavations occur in all parts of the country where there is rock, but they have neither the extent nor the form of those of Rome or Naples. Those of Abousir are no doubt very extensive, but they have not yet been fully explored. There are extensive excavations near Alexandria, which appear from the style of the ornamental parts to belong to the Greek period. The anxiety of the Egyptians to preserve from decay the bodies of their friends and the bodies of sacred animals, may sufficiently account for the number of these excavations, and for their being so well tenanted. For an account of these excavations the reader may consult Belzoni, Salt, Pococke, Legh, Henniker, or any respectable modern traveller in Egypt, and the works of Sir G. Wilkinson. In Peru, and in some other parts of South America, both mummies and catacombs have been discovered. The mummies however are frequently buried in the sand, and the size of the catacombs can bear no comparison with the extent of those of Italy and Egypt.

The catacombs at Paris could not be called catacombs with any propriety until recent times, when, by a decree of the French government, all the churchyards within the city which had been crammed to a loathsome and dangerous degree, were emptied of their contents, and the skulls and bones sent to the spacious subterranean quarries, where they are now arranged in a manner that is grotesquely horrible.

CATALEPSY, or TRANCE (from the Greek *κατάληψις, catalepsis*, literally, "a seizing"), to which is closely allied *extasy*, or the *extatic trance*, is a disease of the nervous system, attended with an abolition of sensation, and of intellectual operation, and with a peculiar condition of the muscles of voluntary motion, those muscles retaining during the paroxysm precisely the same position they were in at the moment of the attack, while the action of the heart and the respiratory functions are but little affected. The malady consists of a great disturbance or an absolute suspension of the functions of the animal life, while the processes of the organic life go on with comparatively little change.

A lively description of a person labouring under a paroxysm of this disease has been given by Dr. Jebb: "My patient," says this physician, who is describing the condition of a young lady who was the subject of this curious malady, "was seized with an attack just as I was announced. At that moment she was employed in netting; she was in the act of passing the needle through the mesh; in that position she became immoveably rigid, exhibiting, in a pleasing form, a figure of deathlike sleep, beyond the power of art to imitate, or the imagination to conceive. Her forehead was serene, her features perfectly composed. The paleness of her colour, and her breathing, which at a distance was scarcely perceptible, operated in rendering the similitude to marble more exact and striking. The position of her fingers, hands, and arms was altered with difficulty, but preserved every form of flexure they acquired: nor were the muscles of the neck exempted from this law, her head maintaining every situation in which the hand could place it, as firmly as her limbs."

This disease is so rare, while it is not unfrequently feigned, that a suspicion has been excited as to the reality of its existence. Without doubt it is often assumed, and that under circumstances which afford no assignable motive for the deception; but still cases are on record, of which that which has just been recited may be taken as an example, which leave no room to doubt that the affection is not invariably simulated, but is sometimes, though not often, a real disease. The disease, when undoubtedly real, is attended with a disturbed state of almost all the functions of the body. There is commonly severe headache, often giddiness, noise in the ears, lassitude, languor, yawning, a disturbed condition of the gastric and intestinal organs, and, more especially, in the male, of the biliary, and, in the female, of the uterine organs. The functions of the spinal cord and brain are at the same time disordered. The whole muscular system is preternaturally irritable or mobile; there is present a long train of symptoms, commonly termed nervous; the intellectual operations are dull and confused, and the temper is mutable and irascible.

During the paroxysm, which commonly comes on quite suddenly, the patient retains precisely the same posture of the body as at the moment of the attack; even the expression of the countenance which existed at that instant remains unchanged as long as the paroxysm lasts; the eyes, whether open or shut, are perfectly fixed; any position in which any part of the body under the influence of the voluntary muscles may be placed, as the head, the trunk, or the limbs, is retained without the slightest deviation; this fixedness and unchangeableness in the attitude giving to the subject of the malady a striking resemblance to a statue.

The countenance during the paroxysm is almost always paler than natural, though it is stated that it has occasionally been observed to be slightly flushed. The skin in general is unusually cold, excepting about the head, where the heat is sometimes even greater than natural, indicating a preternatural determination of blood to the brain, as well as to all the textures that surround it. The action of the heart is so greatly depressed, that it is often altogether imperceptible, and when capable of being distinguished, it is either slow, occasionally below

50 in the minute, or quick and small. The respiration is sometimes incapable of being distinguished, and is never natural; while the processes of secretion and excretion are performed so languidly as to give little or no indication of their existence; and so, the animal functions being abolished, and the organic being performed in so languid a manner as to be imperceptible, the person is sometimes supposed to be actually dead.

After a period of very uncertain duration, sometimes comprehending only a few minutes, and at other times many hours, occasionally, as is stated, even days, consciousness returns generally with the same suddenness as the attack commenced, the return to consciousness being accompanied with sighing, and followed by pain or confusion in the head, and a sense of lassitude and fatigue. No memory is retained of anything that may have passed during the paroxysm, the very same train of ideas returning when consciousness is restored as were present at the instant it ceased; and even, according to some narratives, the very same sentences which had been suspended by the seizure being pursued at the moment of recovery.

In the most severe form of the paroxysm, sensation, intellectual operation, and voluntary motion are entirely abolished; but when the attack is less complete, consciousness is retained. Still there is no power of making the slightest movement of any part of the body, nor even of producing so much as an articulate sound; and several striking and even appalling cases of this latter modification of the disease are on record.

The modification of cataleptic disorder which constitutes the affection termed extasy is generally induced by mental excitement and sustained contemplation of some particular subject, most generally of a religious nature, and more especially when such subjects have raised the passions and engaged the affections. "The patient suddenly seems mentally struck or carried away from all external objects; either standing or sitting in a most excited and impassioned position, with the eyes fixed and open; and sometimes uttering either the most enthusiastic and fervid expressions, or the most earnest denunciations and warnings, or the most absurd exclamations, with the feeling or belief of their reality; and total abstraction from, or unconsciousness of, all surrounding objects or persons."

Such of the cases as were not feigned which some years ago made so much noise in London under the idea of inspiration with "unknown tongues," belong to this affection; the effects produced by the practisers of animal magnetism upon nervous persons are obviously allied to it; and the faculty of improvisation is rarely possessed but under a state of the system perfectly analogous to it; while few who are endowed with this power are in a state of sound health, or consider their faculty otherwise than as a morbid one.

The hypochondriac, the melancholic, and the hysterical temperaments are by much the most predisposed to this disease, while the paroxysm is commonly excited remotely by some disorder of the biliary and digestive organs, or by a suppression or some irregularity of the catamenia; and directly by some powerful mental emotion.

The treatment of the malady must be different in every different case, according to the particular condition of the system, and the nature of the exciting cause. If some derangement of the physical health be the primary cause of the disease, as is almost always the case, the indications of which will commonly be found, if looked for, in the disturbed functions of the brain, the stomach, the liver, the uterus, &c., such remedies must be applied as are calculated to restore these diseased organs to a sound condition.

CATALOGUE (Astronomy.) This is the name given to a list of stars with the means of determining their positions annexed, whether latitudes and longitudes, or right ascensions and declinations. Such a catalogue is not only a register of the stars in question, but also gives the means of computing the effects of precession, aberration, and nutation, and thus finding the absolute place of the star in the heavens at any given time. Another species of catalogue is a register only, being a list of objects which are looked at, not for the purposes of geography or navigation, but as connected with purely physical investigations, such as double stars, nebulæ, &c. The places of the objects are only given to such a degree of nearness as will enable the future observer to lay his telescope upon them. We may place in this list all catalogues of comets; and the whole of this second class requires no further description.

Our own actual knowledge of astronomy, so far as the position of the heavenly bodies is concerned, is contained in the catalogues of stars and the Planetary Tables, the latter of which furnish, not the places of the planets, but the elements by which those places are determined. The names of the principal catalogues will be found in their proper places in the article ASTRONOMY, and there would be no use in repeating them here.

A catalogue, such as is now constructed, shows at one given time the places of a number of stars in right ascension and declination, to which are usually annexed various auxiliary quantities to aid in the reduction of the catalogue to another epoch. These, though useful, are not necessary parts, since they might be supplied by each person for himself, whereas nothing could replace the actual observation made at or near the epoch in question. For the instruments employed in the construction of a catalogue see TRANSIT INSTRUMENT, and CIRCLE. The regular work of an observatory, so far as the stars are concerned,

is the incessant observation of their places, with a view not only to amend preceding results, and to destroy the necessary errors of one observation by the average of many, but also to measure more closely the proper motions of the stars, which have, since accurate catalogues began to be formed, become visible in comparing their results. A catalogue of stars therefore has a value for all succeeding generations in proportion to its goodness; the comparison of two distinct catalogues serves both to determine the precession of the equinoxes and the proper motions of the stars.

The declinations of stars are observed by a method which makes their correctness depend either upon a plumb-line, or more commonly, at the present day, upon a double observation of the star: first, directly; secondly, by means of an image reflected from a surface of mercury. The latitude of the place, and the refractions of the atmosphere, must also be well known. The right ascensions of the stars, relatively to each other, depend upon nothing but the correctness of the instrument employed, and the uniform going of the clock. But the absolute right ascensions of the stars are measured from a fictitious point, the *mean equinox*. The real equinox is the point at which the sun crosses the equator; but as this point moves in the heavens with a motion nearly uniform, but at the same time affected with slight irregularities [EQUINOXES, EQUATION OF], the latter are considered as corrections to be applied when necessary; and catalogues always give the right ascension of the stars as measured from the point at which the equinox would be, if it had its average motion, instead of the real motion. The same fiction is adopted in our measurement of time, which proceeds not according to the real sun, but according to a fictitious body which moves, not in the ecliptic, but in the equator; and not as the real sun moves, but with its average motion. Consequently, the value of the absolute right ascensions of a catalogue depends upon the observer's observations of the sun; these may be wrong, more or less, while his relative right ascensions may be very correct; that is, the differences of his right ascensions may be exact, while all his right ascensions may be wrong by the same quantity, arising from a misplacement of the equinox.

In the mean while, since it is certain that there are stars which are much better known than any others, it is usual to make these, which are called *standard* stars, the sole regulators of the clock, that is, to presume that all the difference of right ascension which appears between the places of these stars as deduced from the catalogue, and that obtained from observation, is the fault of the going of the clock; which, corrected by these observations, is made to determine the right ascensions of stars which are presumed to be not so well known. The tendency of this assumption is, to make the latter species of stars as well known as the former; better they cannot be by such a method. The observations of the sun, by which even the standard stars must be regulated, are best made at the solstices (from which the equinoxes can be deduced), and of course occur only twice a-year. There is in the Nautical Almanac for 1862 a catalogue of standard stars, 147 in number, which are reduced, and their places given for every ten days throughout the year. This last refinement, namely, the selection and constant observation of a few particular stars, is due to Maskelyne (1790 and 1805). The standard catalogue of Maskelyne contained only 36 stars. In the present day, the catalogue used for a similar purpose at the Royal Observatory includes 190 stars.

Looking further back, we find that a preceding epoch begins with Bradley, whose discoveries of aberration and nutation enabled him first to reconcile the discrepancies which his predecessors had detected, but could not account for. Flamsteed (whose catalogue was published in 1725) was the first who habitually observed with the transit instrument to the extent of forming a large catalogue. Hevelius (1690) was the first who determined right ascensions, not however by the transit instrument, but by the old method of measuring distances of stars from each other. Tycho Brahé, the restorer of astronomical measurement, furnished the first catalogue in which any material improvement was made upon that of Ptolemy; for those of Albategnius and Ulug Beg hardly merit such a description. The catalogue of Ptolemy is most probably not formed from observation, but from that of Hipparchus, brought down to the time of the latter by an assumed (but erroneous) value of the precession. Delambre found, by taking the value of the precession, as given by Ptolemy himself, and reducing his catalogue of stars to the time of Hipparchus, that it then presented the state of the heavens more nearly than, as given, it could have done in the time of Ptolemy. ('Astron.,' vol. i. ch. xvi.)

CATALOGUES. [BIBLIOGRAPHY.]

CATALYSIS and CATALYTIC FORCE. Certain substances, when brought in contact with other substances, act upon them in such a manner as to induce a chemical activity; compounds are decomposed, or new ones formed, although the substance by which these changes are induced is not at all affected. To this class of phenomena Berzelius and Mitscherlich have given the name of "catalytic actions," and to the force by which they imagined them to be produced, the name "catalysis," or "catalytic force."

Among the examples of the operation of this force may be mentioned the peculiar actions which certain metallic oxides, such as those of manganese, copper, and iron, exert in facilitating the decomposition of chlorate of potash. When heated alone, this salt is decomposed with some difficulty; to effect its complete decomposition, the application of a high temperature is ultimately required. But if a small quantity of binoxide of manganese, for example, be mixed with the salt, and the mixture heated, the decomposition is effected with the application of a comparatively low temperature; the disengagement of oxygen is regular, but so rapid as frequently to produce incandescence of the mass. In this case the quantity of binoxide appears to be immaterial,—it undergoes no change; the decomposition is effected simply by its presence. As additional examples may be mentioned the following phenomena, which have been ascribed to the operation of this force: The conversion of alcohol into ether and water by means of sulphuric acid, in the process of etherification; many operations of fermentation, such as the conversion of sugar into alcohol and carbonic acid, under the influence of yeast; the conversion of starch into sugar in the operation of mashing wort, or in the germination of seeds, under the influence of *diastase;* and the gradual conversion of amygdaline, the bitter principle of the almond, into hydrocyanic acid, hydride of benzoyle, sugar, and formic acid, when it is dissolved in water and mixed with emulsine.

The peculiar action which platinum exerts in effecting combinations and decompositions, has also been commonly attributed to the catalytic force. When the finely divided form of platinum, known as *platinum black*, obtained by precipitating chloride of platinum by means of zinc, is moistened with alcohol, and exposed to the air, the alcohol rapidly becomes converted into acetic acid. When the same substance is added to a solution of peroxide of hydrogen (HO_2), the latter is immediately decomposed into water and free oxygen. In like manner an acid solution of peroxide of barium (BaO_2), is decomposed into baryta (BaO), and free oxygen. Finely divided platinum has also a remarkable influence in effecting the combination of bodies. When a small quantity of spongy platinum is introduced into a mixture of hydrogen and oxygen it speedily becomes incandescent, and the gases combine with a loud explosion. Similarly, sulphurous acid and oxygen gases, which under ordinary circumstances do not combine, readily do so when passed over gently-heated platinum black. Ammoniacal gas, mixed with excess of oxygen and passed over platinum, is oxidised into nitric acid and water. The reverse operation, that is, conversion of the oxides of nitrogen into ammonia, may also be performed by the agency of platinum. A mixture of binoxide of nitrogen and hydrogen led over gently-heated platinum, yields ammonia and water. $NO_2 + 5H = NH_3 + 2HO$.

The assumption of the "catalytic," as a special force is at least doubtful. Phenomena have frequently been attributed to its operation, simply because a better explanation was wanting. The progress of science has shown that many reactions at first attributed to catalysis, may be explained on known principles, and further knowledge may be expected to leave none of the catalytic phenomena without other and more satisfactory explanation. The curious and interesting actions which platinum exerts, and which are cited by Berzelius as being the most striking examples of catalytic actions, may be more easily explained as being caused by the operation of the surface. According to Döbereiner, platinum black absorbs 250 times its volume of oxygen, which must, therefore, be contained within its pores in a state of condensation greater than that of liquid water. Hence, when platinum black is placed in a mixture of hydrogen and oxygen, or of binoxide of nitrogen and hydrogen, or of sulphurous acid and oxygen, these gases being condensed on the surface have their particles sufficiently approximated to give play to their mutual affinities, and combination is the result. The action of sheet platinum may also be similarly explained; the recent observations of Deville have shown, that ordinary hammered sheet platinum is full of minute pores.

A curious reaction, usually held to be catalytic, is observed when oxide of silver is added to peroxide of hydrogen: oxygen is liberated, and metallic silver precipitated. Of this, and many other similar phenomena Schönbein has suggested some very ingenious explanations in a paper "on the Connnection of Catalysis with Allotropy" ('Phil. Mag.' vol. xiii., pp. 248, 440), and which will be mentioned under the head OZONE. The key to their elucidation will probably ultimately be found in the views first propounded by Brodie in a paper 'On the condition of elements at the moment of chemical change,' read before the Royal Society. ('Phil. Trans.' part ii. 759.)

CATAMARAN is a name given, both in the East and West Indies, to some kinds of rafts which are used in short navigations along the sea-shore. The rafts which are used by the fishermen and others at Madras consist of three logs of timber, each eight or ten feet long, which are lashed together. With these rafts the rowers pass through the surf to fish, or to convey refreshments to ships when no boat could venture off. On the coast of South America the rafts are of considerable size, being made of trunks of trees from 70 to 80 feet long, lashed together, and being from 20 to 25 feet wide: the middle trunk is longer than the rest, and projects beyond them at the after extremity. They carry sails on masts resembling shears; and they are steered by raising or lowering, as the occasion may require, a board which enters vertically between the timbers either at the fore or after part of the raft.

CATAPLASMS, or poultices, are substances applied externally to different parts of the body, either to allay pain and repress inflammation, or more frequently to promote inflammation or its consequences, and lessen the pain attending it. For the former purpose they are

applied cold and generally contain a preparation of lead; for the latter they are of different degrees of temperature. When it is intended to hasten the progress of inflammation so as to lead to suppuration, poultices should be of as high a temperature as the part will bear, but of a lower temperature when they are used as mere emollients. The material of which the poultice is made influences its action, but those are best which have the power of retaining heat and moisture for the greatest length of time. The meal of linseed, especially if the oil has not been expressed previous to reducing the seeds to powder, is the best for all common purposes; but John Hunter complained that this, and all poultices, were generally made too thin. For application to a limited space, such as the lip or eyelid, a roasted apple or fig is best; and a roasted onion is the most suitable application to a boil. Poultices are seldom changed with sufficient frequency. A fresh poultice should always be applied before the one before it has become cold, when the object is to expedite the maturation of a swelling and bring about suppuration. When the surface is broken and suppuration going on, it is not necessary to change the poultice so frequently, as it is desirable to exclude the air as much as possible. To cleanse ulcers, the carrot poultice is a good application, and when there is much irritability or fœtor, the yeast poultice, or one containing charcoal finely powdered are good, but chloride of soda or zinc is better than either. Manganate of potash is also good. [DISINFECTANTS.] The face of a poultice is often coated with oil, and sometimes powdered camphor or red bark may be sprinkled on it, according to the object in view.

CATAPULTA. [ARTILLERY.]

CATARACT (Gr. *καταῤῥάκτης*, in its most common sense, "a fall of water over steep rocks," also, "a door that shuts to," "a bolt, barrier, or obstruction," from *κατα(ρ)-ῥήγ-νυμι*, to break down or interrupt), is an opacity of the crystalline lens or its capsule, which obstructs the transmission of light to the retina, and, according to its degree, impairs or destroys the sight.

To understand its nature, and the means adopted for its cure, the following anatomical facts must be borne in mind. The *cornea* or front of the eyeball is a tough, transparent, and slightly protuberant shell, firmly united to the *sclerotic* coat or white part of the eye. Immediately behind the cornea is a space filled by a watery fluid, the *aqueous humour*, in which the coloured *iris* is suspended like a screen. This membrane, attached by its outer edge to the sclerotic near its junction with the cornea, has the power of contraction and expansion, so as to limit the admission of light through its central opening called the *pupil* to the amount best adapted for vision. Behind the iris and nearly touching it is the *crystalline lens*, inclosed in a transparent membranous capsule, which is attached to what are called the *ciliary processes* behind the external border of the iris. The narrow interval between the lens and *uvea* or posterior surface of the iris is called the *posterior chamber;* the more ample space which separates the iris from the cornea is called the *anterior chamber*. The crystalline is a transparent sticky substance of high refracting power, firmer towards the centre or nucleus, more soft as it approaches the capsule, to which it very slightly adheres. It is nearly flat in front, and swells out behind into a considerable convexity imbedded in a corresponding hollow of the *vitreous humour*. This fluid fills up the remaining space in the globe; it is inclosed in a pellucid membrane termed the *hyaloid*, and seems to consist of water contained in the interstices of a fine cellular structure, which, dividing it into separate portions, gives it a semi-gelatinous consistence. The delicate expansion of the optic nerve called the *retina* is placed, like a cup with the concavity forwards, immediately behind the hyaloid, the edges advancing as far as the attachment of the capsule of the lens; it consequently incloses the whole of the vitreous humour.

The disease we are now in a condition to describe is divided into *true* and *spurious* cataract. The latter term is applied to an obstruction which arises from an opaque film of purulent lymph thrown out by inflammation between the uvea and the capsule, often producing adhesion between these parts, and passing like a gauze blind across the pupil. The usual means which control inflammation in other cases may be used in this, and sometimes effect a cure, but no operation is applicable to it; it may arise from injury, and occurs occasionally in gout and rheumatism, and in some forms of secondary syphilis. The ancients appear to have considered all cataracts to be of this nature.

True cataract is of three kinds: *lenticular*, when the opacity is confined to the lens; *capsular*, when the capsule only is affected; and *capsulo-lenticular*, when both structures participate in the disease. The term, when used simply, is to be understood of the lens itself.

Lenticular cataract.—An important practical division of this complaint is into the hard and soft kinds. The former is the most frequent, and is the variety usually met with in advancing age. Though called *hard* for the purpose of distinction, it may have any consistence, from that which is natural to the part, or less, to the tenacity of wax. The opacity generally begins in the nucleus behind the centre of the pupil, and is at first of a bluish-white colour, like milk and water. This gradually spreads towards the circumference, the nucleus in the mean time assuming an amber-coloured or brownish hue, which sometimes becomes as dark as mahogany, and may extend through the whole lens. The firmness of the cataract is found to bear a close relation to the depth of the tint. Both eyes may be affected at once, but hard cataract more commonly begins in one eye; and after a certain time, from a few months to several years, the other becomes affected in the same manner, and all useful vision is thus eventually destroyed. In this kind of cataract the lens is almost always diminished in bulk, so that upon examination it may be seen to lie at some distance behind the pupil, the movements of which remain free and unembarrassed.

Soft cataract is more frequently single, and prevails in childhood, and the middle period of life. In this form of the complaint the lens, instead of shrinking, commonly enlarges, so as to obliterate the posterior chamber, and press the iris forward towards the cornea. Its texture is everywhere changed and softened: it may be converted into a turbid fluid, in which case the more opaque particles are sometimes observed to subside during rest; or it may have the consistence of soft cheese. The opacity, often streaked and mottled at first, is also general from the commencement, and is found to occupy the whole pupil, even when dilated to the utmost by artificial means. The discoloration varies in shade from a mere cloud to the whiteness of milk; and in the latter case the light is more completely intercepted than by the darkest hard cataract, which always retains a degree of horny transparency, admitting, for instance, the distinction of shade from sunshine; whereas, in the most opaque soft cataract light can barely be distinguished from darkness.

There is a kind of central opacity more allied to the soft than the hard species, in which the affection is confined to the nucleus, and sometimes circumscribed to a mere speck in its centre, the rest of the lens remaining transparent. This affection is most frequently met with in infancy, if it be not absolutely confined to that age.

Capsular or *membranous* cataract commonly appears in specks or streaks of a pearly or chalk-white colour, without the bluish tint which prevails in the early stages of both the former kinds, and more frequently affects the anterior layer of the capsule than the posterior. In the former situation it is close to the pupil, and is plainly convex; in the latter it is concave, but it is not so readily distinguished, as it lies deeper and is seen through the lens, itself usually opaque at the same time: indeed some have doubted the separate existence of opacity in the posterior layer of the capsule, and it is certainly by no means so frequent as in the anterior layer.

Capsulo-lenticular cataract, or that in which both structures are implicated, is much more common. In such cases the lens is usually in the softened state already described. Congenital cataracts are generally of this nature; the opacity, if not *central*, being uniformly diffused, and the consistence never greater, and usually much less than in the healthy state. It frequently prevails among members of the same family; and has a peculiarity which renders an early performance of the operation of essential importance. This consists in a constant rolling and unsteady motion of the eye-ball, which may become habitual, and preclude the patient from ever acquiring the power of directing the eyes at will towards an object. The capsular varieties, especially those which commence in the anterior layer, are more frequently the result of injury, and complicated with inflammatory conditions of the constitution or of the eye itself, than those in which the opacity is confined to the lens. These last, especially the hard cataracts of advanced life, are often strictly local affections, and can neither be classed with inflammatory disorders, nor traced to any constitutional cause.

The symptoms experienced by a person affected with cataract may readily be imagined. The symptom first perceived is a dim haziness of sight, as if a mist or a thin veil were interposed between the object and the eye. The obscurity is greatest in direct vision; in hard cataract, because the opacity is originally central; in soft, because the direct rays pass through the thickest part of the lens, while those which enter laterally are transmitted nearer to the edge, which is comparatively thin. The sight is better, for the same reason, in weak light, and with the back turned to the window, than in strong light: for the pupil in the latter case is contracted, and permits the passage of the rays only through the middle of the lens. Hence also the advantage derived in all cases from dropping the juice of the belladonna or deadly nightshade into the eye, which with some other sedative vegetable poisons, has the remarkable property of dilating the pupil by some specific action on the iris independently of the retina. It is a curious circumstance that this effect is not impaired by repeated applications.

None of the varieties of true cataract are subject to the influence of any known medicinal remedy, whatever may have been put forward to the contrary to serve interested purposes: nor is it at all likely that any remedy exists with powers capable of acting upon parts so obscurely organised, and so completely out of the course of the circulation. No vessels have ever been discovered in the lens under any condition of that part; and it is probably as little endowed with vitality as the hair and nails. Consequently, all the palliation the case admits of is limited to the local application of belladonna, attention to the general state of the health, and care in removing the inflammatory symptoms, with which, as we have seen, it is sometimes complicated. A radical cure can only be brought about by the actual removal of the cataract.

Much difference of opinion has existed as to the most eligible way of effecting this object; but it is now well understood that each of the methods proposed may be the best in its turn, and that the point can only be determined by the circumstances of the particular case.

All the operations for cataract may be classed under three heads, as they are calculated to effect, either its extraction; its displacement from the axis of vision; or its absorption or solution.

Extraction is commonly effected in the following manner:—A fine triangular knife, sharp at the point and the oblique edge, and having the back in a straight line with the handle, and the flat of the blade towards the eye, is steadily and quickly passed through the upper or lower half of the cornea, as near to the iris as possible without touching it. A needle slightly curved at the point is insinuated under the flap thus formed, and brought to bear upon the front of the capsule so as to lacerate it; upon gentle pressure of the globe the lens slips out of the capsule, and easily distending the pupil escapes through the wound in the cornea, which soon heals in favourable cases, and the sight is restored. Spectacles suitably convex must afterwards be worn as a compensation for the refractive power of the lens. This operation is chiefly suited to the hard cataract and the adult age. It is inexpedient in gouty and inflammable subjects, and when the eye is either too prominent or too deep in the orbit.

Displacement of the lens from the axis of vision, which was the method practised by the ancients, is effected in several ways; the most usual is that called depression or *couching* (from the French *coucher*, to lay down). A sharp needle, with edges which cut a little way from the point, is introduced perpendicularly through the sclerotic, near its junction with the cornea, and consequently behind the lens; the pupil having been previously dilated by belladonna. The point is then brought forward through the lens, which, by a backward and downward movement of the hand, is drawn out of its place behind the pupil, and lodged under it in the vitreous humour. The opaque body being thus removed, the sight immediately returns; but as the lens may partially rise again into its place, it is often necessary to repeat the operation at intervals, which has been done a dozen times with perfect eventual success. The lens does not produce so much irritation in its new situation as might naturally be expected, and it is commonly absorbed in part or wholly in the course of time. This method of operating is not very frequently resorted to in the present day.

The third kind of operation, which is intended to cause the absorption of the lens, or its solution in the aqueous humour, is performed much in the same way; but instead of drawing the needle backward, the operator pushes it in through the lens into the pupil, and lacerates the anterior capsule. The aqueous humour is thus admitted to act upon the cataract, which, perhaps, after several repetitions of the operation, becomes absorbed or dissolved, and vision is thus restored. This mode of operating, with variations which need not be detailed, is generally adopted in soft cataract, and always in congenital cases.

It is not only necessary that much discretion should be exercised in the choice and execution of the operation; it must in all cases, more especially in extraction, be preceded and followed by means calculated to prevent inflammation, which often occurs in spite of all precautions, and may render the operation worse than useless. It is not usually thought expedient to operate on one eye while useful vision remains in the other; nor by the method of extraction in both eyes at the same time: nor is an operation warrantable when the patient cannot distinguish light from darkness, which proves that some other cause of blindness exists independently of cataract; nor if the iris or other membranes in front of the crystalline be disorganised by previous inflammation. Many other cases might be enumerated in which an operation is of questionable propriety. On the whole, however, cataract may thus be cured, and useful or even perfect vision restored in a large proportion of cases. The pain of the operation itself is very inconsiderable, nor does any disfigurement or inconvenience arise if it be skilfully performed.

CATARRH, or CORY'ZA, that is, catarrh in the strict sense of the term, commonly called cold, consists of inflammation of that portion of the mucous membrane of the air passages which lines the nostrils. Inflammation, though often strictly confined to this portion of the lining membrane, when it gives rise to the symptoms known under the name of common cold, or coryza, is very apt to extend beyond the nostrils, when it produces other diseases which are distinguished by different names: when, for example, the inflammation extends from the nostrils into the frontal sinuses, pain, and a sense of weight in the head being superadded to the symptoms of coryza, the affection is called gravedo, catarrhal headache, or cold in the head; when inflammation extends to the back part of the throat, the affection is called cynanche catarrhalis, or catarrhal sorethroat; when to the larynx, laryngitis; and when to the bronchi, bronchitis. [BRONCHITIS.]

The symptoms of coryza are a sense of uneasiness, fulness, heat, and stuffing in the nostrils, frequent sneezing, diminished acuteness or total loss of the sense of smell, together with a slight impediment to the respiration, occasioned by the impeded transmission of the air through the nostrils to the lungs, in consequence of the swelling of the membrane, the degree of the swelling being always in proportion to the severity of the inflammation. [BRONCHITIS.] Though the main seat of inflammation in coryza is always in the lining membrane of the nostrils, yet very constantly a sufficient degree of it extends to the frontal sinuses to occasion some uneasiness there, inducing a sense of fulness, heat, weight, and even pain across the forehead. Occasionally, too, the membrane which lines the tube through which the tears pass into the nose becomes so much swollen that the tears cannot enter it, and consequently flow over the cheek; while the external membrane which is reflected over the eye itself participates in the inflammatory affection, and becomes reddened and painful.

These local disorders are often the only symptoms which exist; but whenever the disease is severe, the system becomes affected, and then to these local symptoms are superadded indications of a general disturbance in the economy. These general disordered functions are uniformly those which indicate a feverish condition of the system, namely, chilliness or coldness succeeded by heat, dryness of the skin, lassitude, stiffness, or a sense of uneasiness, often amounting to pain, in the back and limbs, together with a greater or less degree of headache.

The dryness of the membrane affected, in coryza, the first consequence of inflammation, from the suppression of secretion, gives rise to the irritation, the itching, and the sensation of heat in the nostrils, and more particularly at their entrance. Next comes the acrid fluid already described [BRONCHITIS], which flowing upon the upper lip and the anterior portion of the nostrils, irritates and excoriates them, and which, passing by the posterior nares into the pharynx, and thence upon the epiglottis and glottis, occasions violent cough; and last of all flows the bland fluid, with the immediate subsidence of all irritation. [BRONCHITIS.] The causes of coryza are precisely the same as those of bronchitis.

Of all the diseases to which the human body is subject, catarrh is the most frequent, at least in this climate, which is subject to such sudden and great changes of temperature, and where the atmosphere is so often loaded with moisture. Scarcely an individual passes through the year without suffering from it in a greater or less degree. Fortunately its danger is by no means proportionate to its frequency. It is never of itself fatal excepting in the very young and in the very old. But inflammation of the mucous membrane of the nostrils, however slight it may be at first, is very apt to spread to other portions of the membrane, to become severe, and consequently to occasion serious disease. It is the constant source of bronchitis, it often terminates in inflammation of the substance of the lung, and it frequently lays the foundation for consumption. Hence whenever there is the slightest appreciable predisposition to disease of the lung, a common cold, in however mild a form it may come on, ought to be attended to with anxious care. Every year many persons apparently in good health at its commencement are dead before its close, in consequence of two or three days' neglect of a cold.

The disease, at first local in its seat, may often be cured at once, or at all events its severity may be lessened and its duration shortened by the application of a local remedy; such as the inhalation through the nostrils of the vapour of warm water, or what, perhaps, is more effectual, the vapour of an infusion of chamomile flowers, or of a decoction of poppy-heads. The steam from these heated fluids should be made to pass through the nostrils for at least the space of a quarter of an hour or twenty minutes at a time. It is important that the temperature of the apartment be maintained uniformly at a moderate degree, about 65°, the sleeping as well as the sitting-room. With a view of determining to the skin, so as to produce a general and gentle perspiration, the feet, immediately before going to bed, may be bathed for twenty minutes in warm water, and the bed warmed. A tumbler full of wine-whey, or a basin of warm gruel, will promote the perspiration, and under this simple treatment the patient will often arise in the morning without the slightest remains of the disease. A mild aperient may be often added with advantage.

When there is any degree of fever, the treatment must be the same as in bronchitis.

CATCH, in music, a composition of the humorous kind for three or four voices, which owes its origin to this country, and does not appear ever to have travelled out of it. It is a song of as many verses or couplets as parts. The highest part is first sung through alone; the singer of this goes then to the second part, the second voice takes the first, &c., and thus each performer sings through all the parts in succession, and, generally, three times over. The *catch* depends on the distribution of the words among the performers. This is so contrived that a meaning is given to the lines wholly different from that which appears when they are read in a straightforward manner. The catch in "the good old times" was often obscene and disgusting. Among other improvements in manners the abolition of such offensive productions deserves to be mentioned here. Some good catches, however, but of later date, by Webbe, Callcott, &c., remain, which are exceedingly facetious, and such as may be, and are, introduced at any social meeting with propriety.

CATECHIN = TANNINGENIC ACID ($C_{40}H_{18}O_{16}$) is that portion of catechu which is insoluble in cold water. It is soluble in hot water, and crystallises in the form of a white silky powder. When heated with caustic potash it yields a black acid, called *japonic acid* ($C_{12}H_5O_5$). Carbonate of potash produces with it *rubinic acid*, or *rufocatechucic acid* ($C_{18}H_9O_4$), which has a red colour. [TANNIC ACIDS.]

CATECHI'NUM, *Medical properties of.* This peculiar principle is obtained not merely from catechu, strictly so called, but also from gambir and some kinds of cinchona bark. Certain slight differences are found in it, according to the source whence it has been obtained, such as that from catechu having no acid reaction on litmus, while the

others have. The best mode of procuring it is to digest catechu in sulphuric ether, then evaporate the ether, wash the residuum in cold water, repeatedly dissolve it in boiling water, and by renewed evaporation procure it pure. The appearance is that of a white semicrystallised powder (resembling magnesia or grape-sugar), with an astringent taste, which is followed by an unpleasant and somewhat sweetish one. It is persistent at the ordinary temperature of the air, but by long exposure to damp it resolves into a mould-like mass; at a moderate heat it melts into a transparent fluid; by a strong heat it becomes brown.

Of hot water it requires only from three to four parts for its solution, but of cold 16000: of boiling alcohol from two to three, of cold from five or six parts for its solution; of boiling ether it requires seven to eight, while of cold it needs a hundred and twenty for its solution. It is one of the most delicate tests of some of the salts of iron (when these are devoid of any free acid), as it strikes a most beautiful dark green colour, without precipitation; which colour results if there be but $\frac{1}{56000}$ part of iron in solution, only the kind obtained from the *Nauclea gambir*. It does not precipitate either a solution of gelatine or of starch, a peculiarity which distinguishes it from tannin; and which constitutes its claim to attention as a therapeutic agent, as a means of arresting hæmorrhage in distinct organs. Pure tannin is almost certainly precipitated by the starchy or gelatinous principles it meets with in the food in the primæ viæ, and has therefore little influence on hæmorrhage from remote organs. All who know the difficulty of checking the flow of blood in those of hæmorrhagic diathesis, especially from leech-bites, scarification of the gums, &c., will be glad to have a new resource in catechin.

CATECHISM. Almost all our ecclesiastical terms are of Greek origin, and almost all of them may be traced to some word or some expression in the sacred writings. It would perhaps hardly be expected that to *catechise* comes from a Greek compound word denoting the reflection of sound, *κατηχέω*, the reverberation of the voice; yet such is the fact; and the reason that this word has established itself in ecclesiastical affairs to denote the mode of instruction by question and answer without book, which is what is properly meant by catechising, is that Saint Paul has used the word in his First Epistle to the Corinthians, xiv. 19, "that by my voice I might teach others," *κατηχήσω*. The word occurs also in other passages of the Sacred Scriptures, denoting instruction in affairs connected with religion.

Catechising then, etymologically, and according to the primitive usage, is delivering orally instruction in matters pertaining to religion. Whether in this there was anything in common with the notions which seem to have pervaded some of the ancient systems of divinity, that the mysteries were not to be committed to writing, but only handed down traditionally from age to age, may be doubted, since the practice is so easily explained on what is a mere common-sense principle. Christianity was to present herself to innumerable persons who could receive its truths by the hearing of the ear, while they were unable to peruse any writings in which it might be presented to them. Such persons there have always been in every Christian community, and we are quite sure that when the Christian missionaries addressed themselves to nations but a little removed from a state of barbarism, this mode of instruction was the only mode in which what it was necessary for them to know could be communicated. In such a state of society also their answers to a few simple questions, which they would easily learn by frequent repetition, would be accepted as a sufficient profession of faith entitling them to baptism, confirmation, or a participation in any Christian ordinances. In the early church *catechumens* were not admitted to the sacrament, to public prayers, nor to ecclesiastical assemblies, until they had received baptism.

What, in the infancy of Christianity, was the mode of communicating the elements of Christian truth to persons of all ages, has become in process of time the mode of making such communications to the minds of children only. The reason is obvious: we have now seldom any adults who come with minds wholly unfurnished with the elements of Christian truth; children are therefore almost the only persons who now need catechetical instruction. We do not speak of the few instances which society even in this country does occasionally present of persons brought up in utter ignorance of religion and its truths and duties. But children, generally speaking, are now the only persons who need this kind of instruction; and when we use the terms *catechise* and *catechumens*, which last word denotes the persons placed under this mode of religious instruction, we refer them at once to children, and children only. The more wide extension of the ability to read has rendered this mode of introducing to the young the knowledge of Christian principles and duties of less importance, though it is still considered a part of pastoral duty belonging to the Christian minister to catechise the young of his flock, and thus to prepare them for the ceremony of confirmation. To say the least, it is an impressive mode of communicating the elements of Christian truth, and it serves throughout the period of after-life to cement an attachment which it is desirable should always exist between the individuals of a Christian flock and their pastor. The greater extension of the ability to read has also produced another change. Catechisms originally intended for the use of the instructor have been transferred to the instructed, who have learned in them the answers which beforetime they were wont to have only from the mouth of the teacher. By far the most celebrated among ourselves of these catechisms is that which is incorporated in the Book of Common Prayer, an intimate acquaintance with which is held to be essential to every person who is a candidate for confirmation. Innumerable other catechisms have been printed, both at home and abroad, in some of which, however, though they are called catechisms, we recognise but faintly the impression of the peculiar character of this mode of instruction, they being rather bodies of Christian divinity exhibited in the form of question and answer. This is the case with the Racovian catechism, which contains the doctrines of the Polish Socinians. This is the case with the Genevan catechism, which exhibits at much greater length than we can suppose to have been designed to be committed to memory, the principles of Christian truth as professed by the pastors of that city. The Assembly of Divines at Westminster, who, at a time when Presbyterianism was in the ascendant in England, were called together to devise a new form and order of Christian profession, put forth two catechisms: a larger, containing a system of Christian doctrine, with the evidence on which its several parts were supposed to rest; and a smaller, which was intended for the actual catechetical instruction of the young. Both these present a system commonly called Calvinistic.

Catechism is also frequently used now for any system of teaching by question and answer. Thus, we have catechisms of history, geography, chemistry, &c.

CATECHU. The inspissated extract of the *Acacia catechu* is known by this name; but as there are several varieties of this substance, it is probable that it is procured from other species of this genus, as indeed is positively stated by Dr. Wallich, who denies that any catechu is obtained from the *Areca catechu*. Geiger affirms that one variety of catechu is the extract of *Nauclea gambir* (Hunter), which however is generally considered to yield a sort of kino, but it is called gambir. It comes from Singapore. (See Nees von Esenbeck, in Buchner's 'Repert., vol. xxii., p. 185, and Dierbach, in 'Magaz. für Pharmacie,' vol. xvii., p. 106.) The specific gravity differs, that of Bombay being 1·39, while that of Bengal is only 1·28, also their reaction with iron.

At the season of the year when the sap is most perfectly elaborated, the bark of the *Acacia catechu* is removed, and the tree cut down, the outer white part removed, and the remaining brown heartwood cut into such pieces as can be conveniently introduced into a narrow-mouthed vessel; water is poured in, and then boiled down to one-half the original quantity; the further inspissating is conducted in wide earthen vessels. It is then allowed to stand in the sun, frequently turned, and at last transferred to cloths strewed over with the ashes of cow's dung, and cut into four-square pieces, which are then thoroughly dried in the sun. The darker the wood from which it is obtained, the darker the colour of the extract: it has so much the appearance of a mass of earth as to have been once considered such, and called *terra japonica*. The farina or meal of a seed resembling wheat, and called *nachani*, is often mixed with it, not as an adulteration, but to prevent the soft masses adhering to each other.

Catechu occurs either in irregular pieces or in small cubes, of a dark brown colour; odour very faint; taste powerfully astringent, afterwards bitterish, then sweet. It is nearly completely soluble in water, more perfectly in alcohol. Analysed by Sir H. Davy[1]—

	Bombay catechu yielded	Bengal yielded
Tannin	109	97
Extractive	68	73
Mucilage	13	16
Impurities	10	14

The Bombay variety is preferable: it is a valuable astringent, and may be employed either to act immediately on the mucous membrane of the digestive organs, or on remote organs. In all cases of relaxation of the tissues, either accompanied with a flow of blood or increased mucous discharges, or without any obvious discharge, catechu renders great assistance in restoring the parts to a healthy condition. In relaxed uvula or pap of the throat, causing irritation and cough, a portion of catechu melted slowly in the mouth is extremely useful. In diarrhœa, from debility, catechu alone, or combined with prepared chalk and opium is much employed, though chemists disapprove of the combination, on the ground that an inert tannate of lime is formed. It is found however to be practically advantageous. Where the debility is great, aromatics and cordials may be added, provided there be no inflammatory condition of the intestines, a point which should always be most carefully inquired into before administering astringents. [ASTRINGENTS.]

CATECHUCIC ACID. [TANNIC ACIDS.]

CATECHUTANNIC ACID. [TANNIC ACIDS.]

CATEGORY, the word *κατηγορία* (*κατεγορεῖν*, to declare, aver), was used by Aristotle in a manner on which much discussion has arisen (See Mansel's edition of Aldrich, 'Appendix,' note B). Mr. Mansel considers that the distinction arose from the resolution of the proposition, and a classification of the grammatical distinctions indicated by its parts. Thus, taking the Greek terms, presently translated, the noun substantive leads to the category of *οὐσία*, the adjectives of number and quality to *ποσόν* and *ποιόν*, the adjectives of comparison to *πρός τι*, the adverbs of place and time to *ποῦ* and *ποτέ*, the different forms of the verb, intransitive, præterite, active, and passive, to *κεῖσθαι*, *ἔχειν*,

ποιεῖν, and πάσχειν. With this account of the probable derivation we agree.

Aristotle's book of Categories is the first of the six which compose the 'Organon.' By the scholastic authors, Curio, Tonstius, Vives, and others, it is asserted that this book of Categories was written, not by Aristotle, but by the peripatetic philosopher Andronicus, who revised and published the works of Aristotle in the 1st century B.C. There appears to be little foundation for this opinion, since Ammonius, Simplicius, Boethius, and others, in their commentaries on it, indicate no doubt of its genuineness; and the reason for doubt assigned in the analysis of Aristotle's Logic by Dr. Reid in his 'Intellectual Powers,' 1827 (inserted also in Lord Kames's 'Sketches'), namely, an inconsistency in the doctrine of the book of categories, and that of the books of analytics, is not founded on fact; though such misconception might well occur about the meaning of the first chapters of the categories, in which so much subtle and abstruse definition is occasioned by the Greek language having but one word οὐσία (ousia), to express 'substance' (all the essential and accidental qualities of an object) and 'essence' (all the essential qualities only). Aristotle's frequent mention of the book of Categories, and above all, as Mr. Taylor in his translation remarks, the obscurity and difficulty of the sentences, and the involved diction, are evidence that Aristotle is the author. But similar classifications were formed before the appearance of the 'Organon.' In a treatise by the Pythagorean philosopher, Archytas of Tarentum, entitled περὶ τοῦ παντός (concerning the universe, or, as Taylor says, universal terms), the arrangement adopted by Aristotle was set forth and discussed. Through Plato, the disciple of Archytas and preceptor of Aristotle, the theory of the Aristotelian Categories descended from the school of Pythagoras, in whose system 10 was a number replete with sacred mystery ('Denarius Pythagoricus,' by Meursius, c. 12; and 'Pythagorean Decad.,' in 'Theoretic Arith.,' by T. Taylor, c. 12). The work of Archytas is copiously cited in the commentary of Simplicius on the ten Categories. The extant fragments were also published separately in 1571, 8vo., Venice. Archytas and the other Pythagoreans considered these ten universal ideas as the principles of all things—the causes of the universe,—a doctrine which requires for explanation a reference to the Pythagorean and Platonic theory of ideas. By Aristotle and the peripatetics in general they were proposed merely as comprehensive forms of predication, by which the perplexing variety of human ideas were supposed to be conveniently arranged for the use of the dialectician. All the objects and modes of human thought were thus distributed as species under ten *summa genera*, or universal terms, to facilitate a comprehensive survey of the τὸ πᾶν, the whole physical and metaphysical world, known and unknown. The names of the ten Categories, as enumerated by Aristotle ('Cat.' c. 4, and 'Top.' l. i. c. 9) are: 1, οὐσία or τί ἐστι; 2, πόσον; 3, ποῖον; 4, πρός τι; 5, ποῦ; 6, πότε; 7, κεῖσθαι; 8, ἔχειν; 9, ποιεῖν; 10, πάσχειν; which are variously expressed in English by different writers. In Dr. Whately's Logic they are rendered as follows: "substance, quantity, quality, relation, place, time, situation, possession, action, suffering;" but to perceive the meaning of the Greek terms, it must be observed what Aristotle comprehends under each of these general designations: ἔχειν, for instance, is said to signify the having something attached to the person; to be "booted, armed" (τὸ ἔχειν σημαίνει τὸ ὑποδεδέσθαι, τὸ ὡπλίσθαι 'Cat.' c. 9); but in the last chapter of the Categories eight modes of having are enumerated. The first four categories, namely, 'οὐσία, πόσον, πρὸς τί, ποῖον,' are elaborately explained by Aristotle in four long chapters; the definition of the remaining six is despatched in a word or two, but the nature and properties of all are more fully defined incidentally throughout the rest of his works. That they are classifications only of words was maintained by some of the ancient philosophers ('Philos. Arrangements,' by Harris, p. 16). Concerning the question whether these universals are real existencies or merely names or conceptions, see the remarks on the Realists and Nominalists in Dr. Reid's 'Essays,' c. 5 and 6. In the later ages of Latinity these Categories were denominated prædicaments; the name by which they have since been generally designated in the scholastic works on logic, in which they are usually translated and placed as follows: "substantia, quantitas, qualitas, relatio, actio, passio, ubi, quando, situs, habitus," and illustrated by the following jargon as an aid to memory.

"Arbor, sex, fervore, patres, refrigerat, ustos,
Ruri, cras, stabo, nec tunicatus ero."

As to the utility of these ten Categories, it may be remarked that they were made to form an essential part of the mediæval system of logic, which was rejected as useless by many of the principal philosophical writers of the last three centuries, such as Bacon, Hobbes, Descartes, Locke, Condillac, Reid, Kames, Stewart, Brown, De Stutt Tracy, &c. But they do not properly belong to logic at all; and those who rejected logic, and those who maintained the logical character of the categories, fight with each other a battle in which modern opinion sides with neither. It was affirmed that the categories were used but to maintain among the illiterate the reputation of universal knowledge; that they served only to support syllogistic argumentation for victory, and supplied a convenient ready-reckoner, by which a prompt solution could be given even to questions beyond the reach of human knowledge, and in reality quite unanswerable. The lovers of satire may

turn to Gassendi's 'Exercitationes adversus Aristoteleos,' where the ten Categories are unsparingly treated. The remarks of Hobbes in his Logic ('Opera Philosophica,' 4to, 1688) are no less satirical: "Fateor me prædicamentorum usum hactenus non magnum perspexisse; cepit opinor Aristotelem libido quædam pro authoritate sua, cum rerum non posset, verborum tamen censum peragendi," p. 16. So the authors of the 'Port Royal Logique, ou l'Art de Penser' (Nicole and Arnauld), p. 21, "Voilà les dix Categories d'Aristote, dont on fait tant de mystères—à dire le vrai, c'est une chose *très peu utile*—toute arbitraire, et qui n'a de fondement que l'imagination—elle accoutume les hommes à se payer de *mots*; à s'imaginer qu'ils savent toutes choses, lorsqu'ils n'en connaissent que des noms arbitraires:" and De Stutt Tracy, 'Logique,' p. 22, "Cela n'est utile absolument à rien." It would be endless to quote similar opinions from the best modern works on the subject. On the other side, among the defenders of the Categories are Monboddo, Harris, Gillies, and T. Taylor. Harris, in his elaborate work on the subject ('Philosophical Arrangements,' p. 34), says "The doctrine of these Categories is a valuable, a copious, a sublime theory—a theory which prepares us to study every thing with advantage:" p. 462, "There are few theories so great, so comprehensive, so various, as the theory of these Categories: in contemplating them we see whence the sciences and arts all arise—history out of substance; mathematics out of quantity; optics and medicine out of quality and quantity; astronomy, music, and mechanics, out of quantity and motion; painting out of quality and site; ethics out of relation; chronology out of when; geography out of where; electricity, magnetism, and attraction out of action and passion," &c. In the Categories of Kant ('Kritik der Reinen Vernunft,' 7th ed., 1828), the precise boundaries of human knowledge, *à priori*, are professed to be exhibited; these Categories consist of four primordial classes: 1, quantity; 2, quality; 3, relation; 4, modality; each class containing three Categories: 1, unity, multitude, totality; 2, reality, negation, limitation; 3, substance and accident, cause and effect, action and reaction; 4, possibility, existence, necessity.

That in treating of extensive subjects, some similar methodical classification is very useful and necessary for perspicuity and brevity, is obvious. A tabulated view of Locke's arrangement of ideas (his Categories, as they are sometimes named) is given to great advantage on a large sheet prefixed to the edition of his Essay in 1828. Among the ancients different names and numbers of categories were adopted by different sects: by Aristotle and the peripatetics they are variously called καθόλου λόγοι, universal terms; σχήματα κατήγορίας, forms or figures of predication; κατηγορίαι, categories; γένη γενικώτατα, the most comprehensive genera; τὰ πρῶτα δέκα γένη, the ten primary genera. Plato reduces them to five; namely, οὐσία, ταυτότης, ἑτερότης, κίνησις, στάσις; substance, identity, diversity, motion, rest. The stoics made four: namely, ὑποκειμένα, ποῖα, πῶς ἔχοντα, πρός τι πῶς ἔχοντα; subjects, substances, modes of being, relative modes of being. Some philosophers have preferred seven: namely, spirit, matter, quantity, substance, figure, motion, rest: others three, namely, subject, accident inherent, accident circumstantial; others make only two, simply, substance and attribute, or subject and accident. Other philosophers arrange all existent things under the following six categories:

"Mens, mensura, quies, motus, positura, figura,
Sunt, cum materia, cunctarum exordia rerum."

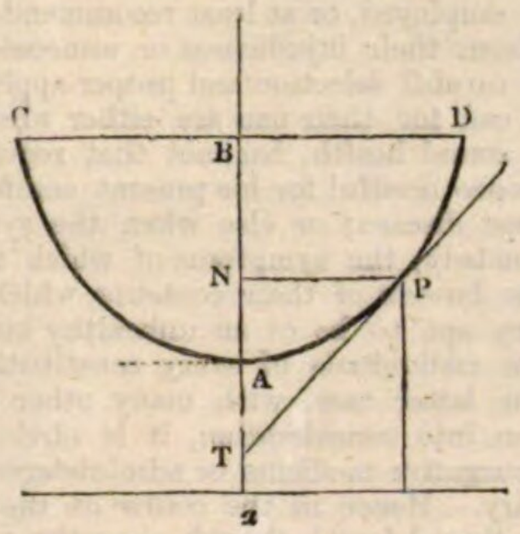
Cicero and Quintilian name the ten Categories of Aristotle 'Elementa Dialectica.'

(See Ammonius, *Comment. in Categ. Græcè*, 12mo, Venice, 1545; same in Latin by Silvanius, Paris, 1542; Simplicii *Comment. in Prædic. Aristot.*, fol., 1567; *Analysis of Aristotle's Works*, by Dr. Gillies, 4to, p. 58, *et seq.*; Monboddo, *Origin of Lang.*, vol. i. p. 317, *et seq.*; vol. v., p. 416; and *Antient Metaphysics*, vol. i. pp. 26, 311, 329; Boethii *Aristot. Dialect.* fol. 1560, p. 106, *et seq. in Categor.*; Stewart's *Elem. Philos. Mind*, vol. ii., *on Aristot. Log.*; *The Organon, Comment.* by Pacius, 4to, 1605. The English translation by T. Taylor, 4to, 1812, contains the substance of all the chief Commentaries.

CATENARY (from *Catena*, a chain) is the curve in which a string of perfect flexibility and uniform thickness and density will hang from two points, which we may suppose to be in the same horizontal line, as the nature and properties of the curve will be the same from whatever points it may hang. And all catenaries are similar curves; that is to say, let there be any number of such curves formed by chains of different lengths, then each of them will be a picture, on a reduced or enlarged scale, of some portion of the longest.

Various properties of catenaries have been investigated, in cases where the thickness or density of the string are variable. See in particular Creswell's translation of Venturoli's Mechanics, and Whewell's Analytical Statics. We shall here confine ourselves to the most common properties of the catenary, which, with the modifications always required when we come to apply the mathematics of a flexible and inextensible chain to the materials of the architect, is the first step towards the theory of the suspension bridge. Let C and D be the two points of suspension, C A D the chain, of which A is the lowest point, and A B a vertical passing through it. Let the units be inches and ounces (any others might be used), and let the weight of the chain be k ounces to the inch; let t be the length of chain equivalent to the tension at A, and T that equivalent to the tension at P, a point whose

abscissa is A N or x, and its ordinate N P or y. Let the length of the arc A P be s, and the angle N T P be θ. Let Aa be made equal to t inches, and through a draw a horizontal line $a\ p$. Hence if C A were taken away,



and the chain suffered to hang over a fixed point at A down to a, the part D A would not alter its form. And it is the most striking property of the curve, that if the portion D P above any point P were taken away, and the chain suffered to hang over a fixed point at P down to the same horizontal line $a\ p$, the part C A P would be maintained by the portion P p in its position.

The following are the equations which connect T t, x, y, s, and θ:

$$T = t + x = \sqrt{s^2 + t^2},\ \tan.\theta = \frac{t}{s}$$

$$s = \sqrt{2tx + x^2} = \frac{t}{2}\left(\epsilon^{\frac{y}{t}} - \epsilon^{\frac{y}{t}}\right)$$

where ϵ = base hyp. log. = 2·7182818 . . .

$$y = t \text{ hyp. log.} \left(\frac{x}{t} + 1 + \sqrt{\frac{x^2}{t^2} + \frac{2x}{t}}\right)$$

Given the distance between C and D $= 2c$, and the length of the whole chain C A D $= 2l$, then the value of θ at the point D, supposing a tangent drawn there, must be found by approximating to a solution (θ being unknown) of

$$\frac{c}{l} = \tan.\ \theta \text{ hyp. log. cot. } \frac{\theta}{2}$$

which might be solved by inspection, if a sufficient table of the values of the second side were formed. The extreme value of θ being thus found, which call λ, t is found from $t = l \tan.\ \lambda$, and thence the tension at any point of the curve can be found; and A B, which call h, is found from $h = \sqrt{l^2 + t^2} - t$. The preceding equation may be thus adapted to the common logarithms,

$$\frac{c}{l} \times \cdot 4342945 = \tan.\ \theta.\ \text{com. log. cot. } \frac{\theta}{2}.$$

But in practice it would be sufficient to hang up a thin metal chain against two points in a vertical board, in such manner that C D and C A D should represent the lengths required on any convenient scale. Then A N and A P should be measured for several different points, and

$$\frac{(\text{AP})^2 - (\text{AN})^2}{(2\ \text{AN})}$$ should be found for each.

If the catenary were perfect, these should all give the same result, namely, the required value of t; but as this will not be found to be the case, a mean of the values should be taken.

When AB is small compared with C D, λ must be nearly a right angle, and t is very great. The catenary in that case is very nearly a part of a parabola, which it was supposed to be altogether by Galileo. The focal distance of that parabola is the half of t. We have seen people puzzled to know how a horse on a towing-path draws a heavy boat by a rope which appears slack, and even dips into the water. The reason is, that the tension necessary to pull a long rope into anything like a straight line, is much greater than that which is necessary to move the boat. A full geometrical account of the catenary, with tables, is given in Ware's 'Tracts on Vaults and Bridges.'

CATGUT STRINGS. Several useful articles, manufactured from the intestines of the sheep, are, for some unexplained reason, denominated catgut. The catgut is generally in the form of cord, string, or twine. The chief purposes to which such cord is applied, are musical strings for harps, violins, and guitars; hatters' bowstrings, for the bowing or disentangling of fur and wool; clockmakers' cord; and thongs or cords for whips—for all of which purposes the material requires a careful preparation before being brought into the state of cord.

The intestines, when taken from the animal, are, by repeated washing and scraping, freed from the loose adherent matters; and are further steeped for some time, as a means of loosening the surface membranes. When this steeping has brought them to a particular state or stage, they are laid on a sloping board, and scraped with the back of a knife, in such a manner as to peel off two strips of peritoneal or external membrane, each equal in width to half the circumference of the intestine. The membrane so removed is called by the French *filandre*, and

is employed by them, when further prepared, for making the cords for rackets and battledores, and also as thread for sewing pieces of intestine together for other purposes. When the membrane is removed, the intestine is again steeped in water, and the inner or mucous membrane scraped from it; and it is also exposed to the action of an alkaline ley, until at length it is brought to as clean a state as possible. The large ends are cut off and applied to other purposes; the smaller ends are laid by for making cord.

In the making of violin-strings, after a process of cleaning, the intestines have a certain degree of twist imparted to them. Two or more are affixed, at the ends, to a rotating machine, and twisted round each other somewhat in the same way as twine or silk. The size of the membranes, and the number of them twisted together, depend on the thickness of the string to be made. The twisted strings are exposed to the action of sulphur in a closed chamber, and are then rubbed with a horsehair cloth; these processes are repeated two or three times. If a string be sulphured too much, it becomes too brittle; if too little, it rarely keeps in tune; the determination of the proper degree of sulphuring becomes therefore a nice point in the manufacture.

The Italians have generally the reputation of making better violin-strings than any other people. The violinists of England, France, and Germany acknowledge the fact, but without being able to assign a sufficient reason for it. The late Dr. Ure suggested the following considerations: It is well known to physiologists that the membranes of lean animals are far more tough than of those animals which are fat or in high condition. In London, where the sheep slaughtered are mostly fat and high-conditioned, the membranes of the animal are supposed to be less tough and tenacious than those of Italy, which are not so highly fed; hence it is inferred that the membrane employed by the Italians is better fitted for the manufacture than that used by the English manufacturers. Whether this be so or not, the fact of the pre-eminence is admitted. Otto, in his 'Treatise on the Violin,' (translated from the German by Mr. Fardely), says in relation to violin strings: "The best strings which have come under my observation are those from Milan, which are sold under the name of Roman strings; they are now to be had at almost every music shop. I shall point out the signs by which the best strings may be distinguished; as there are some imitations of them manufactured at Neukirch, in Voigtland, in Bohemia, and in the Tyrol, which are sold for Italian. The Milanese strings are as clear and transparent as glass. The third string should be equally clear as the first. They must by no means feel smooth to the touch, for they are not ground or polished off by any process, as all other manufactured strings are. If a good string be held by one end in the finger, and opened out, it will recoil to its former position like a watch spring. Every string, when stretched on the instrument, should look like a thin strip of glass on the finger-board: those which are of a dull and opaque appearance are useless. The Milanese strings are also distinguished by each separate one being tied twice with red silk; which however the Neukirch string-makers have imitated. Their elasticity is after all the best criterion; as no other strings which I have tried have that strength and elasticity for which the Milanese are so much esteemed."

The thickest string of the violin, and many other musical strings, are coated with an envelope of fine wire. This is done by stretching the string very tightly, applying the wire at one end of it, and causing the wire to coil helically round the string by giving it a rotatory motion.

For the strong thick cord used for hatters' bowstrings, the largest of the membranes are used, after being cleansed and prepared; from four to twelve of them being twisted together, according to the size of the cord to be produced. The pieces are twisted to a length of fifteen, twenty, or twenty-five feet; and to effect this, pieces of the membrane are sewed end to end, till they produce the required length. While under the process of twisting, the cord is well rubbed between the fingers, to equalise the thickness. The cord is exposed twice to the fumes of sulphur, and is rubbed repeatedly afterwards.

The catgut employed by clockmakers is prepared from the smaller intestines, well prepared with potash. The hollow membranous tube is sometimes cut into two strips in a curious way. The tube is drawn over a ball, behind which is a kind of knife having two cutting edges or blades, whereby the tube is ripped up into two oblong strips of equal width. The method somewhat resembles that by which straws are split for the straw-plait manufacture. For larger and stronger purposes, clockmakers sometimes use cord composed of two or more intestines twisted together, as for violin-strings. The catgut for whips and similar purposes is prepared and wrought much in the same way; short pieces being sewed together to produce a piece of the requisite length, and this being twisted to give it a sufficient degree of strength. The bands or cords for turning-lathes used generally to be formed of coarse horse-gut; but these are now mostly superseded by India-rubber bands.

For the mode of preparing, from a membrane covering the intestine of the ox, the fine pellicle known by the name of "gold-beaters' skin," see GOLD-BEATING.

CATHARTICS are material agents which cause a transient but special irritation of the intestinal canal, followed by alvine dejections. It is not necessary that these substances should be placed in direct or immediate contact with the mucous membrane of the intestines, either

at its upper extremity (the mouth) or at its lower extremity (the rectum); many of them, when applied to the skin, or injected into a vein, will produce the same effect. This irritation is felt at first merely by the mucous membrane, but secondarily it excites the muscular coat so as to increase the peristaltic and vermicular motions of the intestines. The irritation differs in kind and degree. When it affects the membrane merely so far as to occasion a gentle local action, and is followed only by the expulsion of the matter then resting upon or covering it, without augmenting the quantity or altering the nature of this matter, the agents which produce such effect are termed *laxatives*. But if the action be more considerable, and not only the present contents be expelled by their effect, but also the quantity of the secretions of the canal be increased, and their quality perhaps greatly altered, they are termed *purgatives*: and, according to the particular secretion which they most obviously augment, they receive their appropriate name—chologogues, if it be the bile: hydrogogues, if merely the serous fluid. Their effects also frequently extend to the whole system. If their action be very violent, they are designated *drastic* purgatives.

To comprehend fully the manner in which cathartics act, it is necessary to direct our attention to the structure and functions of the intestinal canal. This canal extends from the mouth to the rectum, comprising the organs of taste and mastication, of insalivation, the stomach, and the small and large intestines. It is lined with a mucous membrance, the folds or plaits of which increase its surface, while the follicular glands which it possesses pour out a viscid mucus, a quantity of which is essential to the due execution of its office: this quantity is often much increased by certain purgatives, as we see by the glairy mucous stools. Independently of the juices poured from the glands and vessels into the stomach, the duodenum, or upper small intestine, receives the extremity and contents of the gall-duct and that of the pancreas. Many purgatives in their passage stimulate these ducts, and excite the glands connected with them to increased action. Beneath the mucous membrane is the muscular coat, the chief agent in effecting the propulsion of the contents of the canal. It consists of two sets of fibres, the one arranged in a longitudinal direction, the other in a circular manner. The regular and progressive contraction of these is necessary to move the contents of the canal onwards along its course. The contraction of the one resembling the contractions of a worm in its progress, is termed *vermicular*, and the other *peristaltic*. When their contractions do not harmonise, colicky pains are felt, and are of frequent occurrence during the operation of purgatives, many of which powerfully stimulate this coat to action. When the muscular coat has its action inverted, and the contractions take place from below upwards, instead of from above downwards, it is termed the *anti-peristaltic* motion, by which the contents of the intestines are often ejected by the mouth, as happens in ileus and some other diseases. The last coat or serous membrane, called also peritoneal coat, only obeys the laws of the preceding two in respect to its motion or quiescence. In addition to these structures, the intestines receive numerous arteries, and when an irritant affects them, the blood flows thither in increased quantity. The contact of a purgative causes the capillaries to enlarge: the inner surface of the intestines becomes redder, swollen, and warmer—a state generally followed by a large increase of the serous exhalation from the extremities of these vessels. Lastly, the nerves of the intestines are mostly derived from ganglions of the great sympathetic, by which an important connexion and sympathy is kept up between the intestines, the brain, and spinal chord.

All parts of the intestines do not feel in an equal degree the effect of a cathartic irritant. Some purgatives act more on one part than another, but it may be stated generally that the duodenum, the colon, and the rectum are most under the influence of them. Cathartics also differ essentially in their mode of action, as well as in general in dose, according as they are derived from the mineral or vegetable kingdom. All those from the mineral kingdom, with the exception of calomel, are neutral salts, and are in their secondary effect pre-eminently antiphlogistic, while their dose is considerable. Owing to their solubility they are frequently given dissolved in water, which influences their action. Those from the vegetable kingdom have nearly all a more or less fœtid odour, which often causes the stomach to revolt, and occasions nausea. Their impression upon the organs of taste is often bitter and very disagreeable. They generally contain a large proportion of bitter and extractive matters, resins, and gum-resins. Their dose is often very small, from a quarter or half a grain to a very few grains: hence they are often administered in the form of pill, bolus, powder, or electuary, more rarely dissolved in water, sometimes in wine or alcohol, or in the form of extract simple or alcoholic. Several of those from the vegetable kingdom may be applied to the skin, and will produce the usual effect either by rubbing in, as with castor-oil, or spread on the face of a poultice and applied over the abdomen for a short time. Scarcely any articles from the animal kingdom are used as purgatives, though ox-gall and the roe of certain fishes are deemed laxative. Many fruits, both in their fresh state or preserved, such as prunes, are mildly cathartic. The sudden application of cold to the surface of the body frequently has a useful cathartic action.

By the combination of many purgative substances in the same prescription, their effect is rendered more certain, and at the same time milder. It is also frequently very advantageous to combine purgatives with emetics, or with tonics.

With respect to the practical employment of purgatives, general rules only can be given here. There is scarcely any disease in which they have not been employed, or at least recommended; but as much injury may result from their injudicious or unnecessary employment, as good from their careful selection and proper application. The circumstances which call for their use are either where an individual, enjoying otherwise sound health, has not that regular action of the bowels which is at once needful for his present comfort and desirable as a safeguard against disease; or else when the system is labouring under some other malady, the symptoms of which are aggravated by the retention in the bowels of their contents, which, under such circumstances, are very apt to be of an unhealthy kind. But as these states may occur in individuals of every constitution, and may be accompanied, in the latter case, with many other symptoms which require to be taken into consideration, it is obvious that it is not enough that some purgative medicine be administered: an appropriate selection is necessary. Hence in the course of the same disease (for example, during continued fever), though purgative medicines may be necessary through its whole course, very different medicines must be employed towards the latter stage from those at the beginning. No person unacquainted with medicine would think of treating a case of severe fever, where professional assistance could be obtained, but yet in other diseases, or even where there is no disease, unprofessional persons undertake to decide for themselves or others when a purgative medicine is necessary, and what it should be. The late Dr. Reid stated it as his conviction derived from extensive observation at a dispensary, that one half the children that died in London under two years of age were killed by mothers and nurses dosing them with rhubarb and magnesia. For very delicate children nothing can be worse than the frequent use of magnesia. Even grown up persons may be injured by it, either by its debilitating action, or by its accumulating in the intestines: a mass weighing six pounds has been found in the intestines of a person who had frequently used it. Drastic purgatives, especially of a resinous kind, such as scammony or camboge, when frequently repeated, deprive the inner coat of the intestines of its covering of mucus, and excite inflammation, which often terminates fatally. Excessive purging also may result from an over-dose, and plunge the person into such a state of debility as to place him in imminent danger, or even cause death, either immediately or remotely.

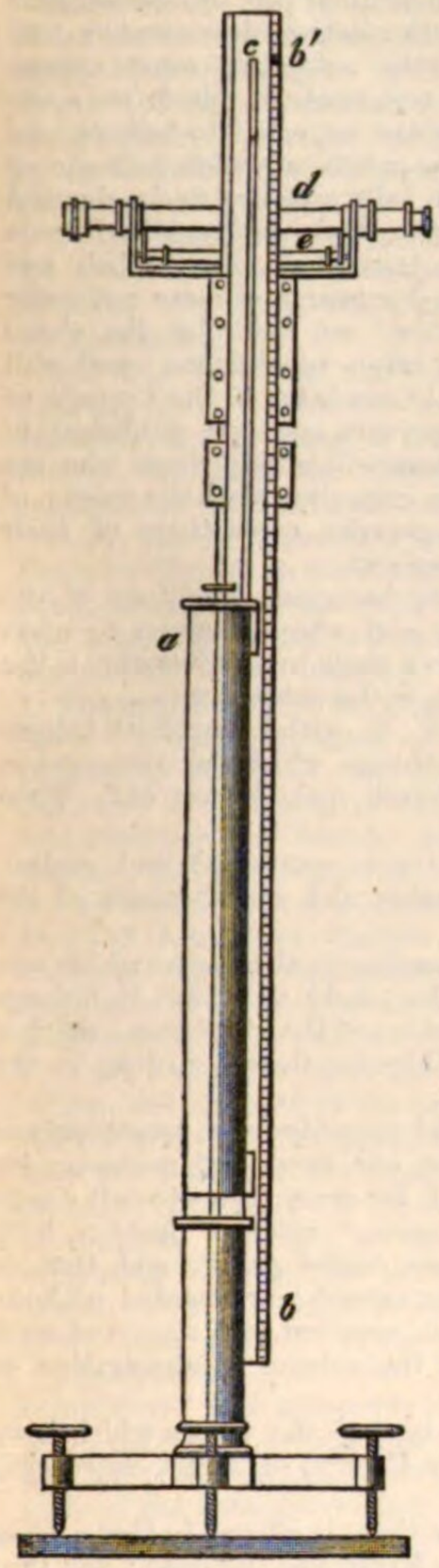
Habitual constipation certainly requires to be remedied, but this is best done by mild laxatives, diet, and proper exercise. When the fault is in the rectum merely, enemata of warm water or gruel may be used, for a few times at first, to remove and prevent accumulations in this part of the bowel. But even these apparently simple means should not be had recourse to without medical advice, as the nature of the constitution of the individual must be taken into consideration, and certain precautions observed. It is frequently serviceable to confine persons of a scrofulous habit to the house during the use of purgatives, as they are peculiarly liable to be affected by cold before their operation has passed off. A layer or roller of flannel over the bowels is beneficial in such persons, especially in winter, during the operation of purgatives. A similar belt is useful in *spontaneous diarrhœa*, especially if cholera, either English or Asiatic, be prevalent. The opposite state to constipation, diarrhœa or looseness, is often best treated by purgatives, especially if it arise from the presence of any undigested food, or unhealthy secretions in the intestines. The mucous fever and diarrhœa of children yields to purgatives sooner than to any other means. The same may be said of many spasmodic diseases, especially in children and females; but as in the treatment of these complaints medical superintendence cannot be dispensed with, we deem further remarks unnecessary. (Hamilton 'on Purgative Medicines,' 8th edit.)

CATHARTIN, the active principle of the various species of *Cassia*, which are used under the name of Senna.

CATHEDRAL. Certain churches are called cathedrals or cathedral churches. They are so called in consequence of having a seat of dignity (*cathedra*, a Greek term for such a seat) appropriated to a bishop or archbishop. Thus there is the cathedral church of Canterbury, the cathedral church of Norwich, the cathedral church of Wells. [CHURCH.] They have usually also a dean and body of canons or prebendaries: but this is not essential to constitute a cathedral church, nor is every church that has a chapter of canons a cathedral church. [BISHOP; CANON.]

CATHETOMETER (from *κάθετος*, a vertical line, and *μέτρον*, a measure), is an instrument for *measuring* the difference in level (that is, the *vertical difference* in height) between two liquid columns in equilibrium. It was devised by Dulong and Petit in the course of their researches on the dilatation of liquids by heat, and has been improved in form by Pouillet, who also gave it the name of *cathetometer*. [HEAT.] Regnault has made great use of it in his researches; and, as M. Jamin observes in his 'Cours de Physique,' "there is no more convenient piece of apparatus, when it is well managed; none more fallacious, when badly regulated." In its *simplest* form, it consists merely of a telescope sliding vertically on an upright scale, the motion of which between the two levels shows the difference of their heights. An example of its application will be seen under BAROMETER.

We will now describe briefly the cathetometer, in the form used by M. Pouillet. The instrument is supported upon a base, which is placed and kept level by means of three screws. From this base rises a rigid vertical axis, to which is fitted a case (*a*) turning freely round it; and to the case is fixed a divided scale (*bb'*,) moving along with it. The scale is further fixed, so as to be inflexible, by means of the rod (*c*), while a horizontal telescope (*d*), with its level (*e*), moves up and down throughout the whole length *bb'*, and the support of the telescope is fitted with a vernier. The telescope has in its interior a pair of spider-threads, crossed at right angles, so that when the image of a point is seen to coincide with the point where the threads cross, we are sure that this point is on the optic axis of the instrument.



In order to set and test the cathetometer, the telescope is placed horizontally at first by means of its level, and the screws in the base are then turned until the level remains perfectly at rest during an entire revolution of the scale round the axis of rotation.

Suppose, then, that we have to measure the difference in height between two liquid columns, which communicate, as in Dulong's experiment, by a horizontal tube. While the liquid is of the same temperature throughout, the level will be, of course, the same in both. This being the case, place the telescope of the cathetometer so that, on turning it round horizontally, both levels will appear successively at the crossing of the spiders' threads, while some other mark, previously fixed, shall appear at the same place. Then, on surrounding one of the columns with melting ice, and the other with hot water, one level will fall and the other rise; and we have only to raise the telescope a certain distance above the fixed point to know how much the one has dilated, and to depress it so much below that point to find the contraction of the other; whence the *absolute* dilatation of the liquid may be easily found.

CATHOLIC CHURCH (Roman).* Although in ordinary language this name is often used to designate the ruling authority or power in the Catholic religion, as if distinct from the members of that communion, yet the definition which Catholics give of the Church is such as to comprehend the entire body of its members as well as its rulers, the flock as much as the shepherds. Thus we hear of Catholics being under the dominion of their Church, or obliged to obey it, as though it were something distinct from themselves, or as if they were not a part of their Church. This preliminary remark is made to explain a certain vagueness of expression, which often leads to misapprehension, and serves as the basis of incorrect ideas regarding the peculiar doctrines of that Church—a vagueness similar to what is frequent in writing and speaking on jurisprudence; as, for example, where the government of a country is considered as a power distinct and almost at variance with the nation which it rules, and not an integral part thereof.

The Catholic Church therefore is defined to be the community of the faithful united to their lawful pastors, in communion with the see of Rome or with the pope, the successor of St. Peter and vicar of Christ on earth.

Simply developing the terms of this definition, we will give a brief sketch of the constitution or fundamental system of this Church, under the heads of its government, its laws, and its vital or constitutive principle.

I. The government of the Catholic Church may be considered

* It may prevent a possible misconception to note here that the plan adopted in the 'Penny Cyclopædia,' and adhered to in the present work, in reference to articles intended to give an account of the doctrines held by particular Churches and communities, was, whenever practicable, to obtain an authentic statement of those doctrines from some person of acknowledged position in the body itself, and to confine the article strictly to such a statement. Thus the article Catholic Church was written by a Catholic clergyman of eminent learning and ability, who has since been elevated to a high dignity in that Church: and it is here reprinted exactly as it originally appeared, as far as regards the principles, and with only the corrections rendered necessary in the historical portion by the events that have occurred since the original was written.

monarchical, inasmuch as the pope is held in it to be the ruler over the entire Church, and the most distant bishop of the Catholic Church holds his appointment from him, and receives from him his authority. No bishop can be considered lawfully consecrated without his approbation. The dignity or office of pope is inherent in the occupant of the see of Rome, because the supremacy over the Church is believed to be held in virtue of a commission given to St. Peter, not as his own personal prerogative, but as a part of the constitution of the Church, for its advantage, and therefore intended to descend to his successors, as the episcopal power did from the apostles to those who succeeded them in their respective sees.

The election of the pope, therefore, devolves upon the clergy of Rome, as being their bishop; and it is confided to the college of cardinals, who, bearing the titles of the eldest churches in that city, represent its clergy, and form their chapter or electoral body. The meeting or chapter formed for this purpose alone is called a *conclave*. The cardinals are in their turn appointed by the pope, and compose the executive council of the Church. They preside over the various departments of ecclesiastical government, and are divided into boards or congregations, as they are called, for the transaction of business from all parts of the world; but every decision is subject to the pope's revision, and has no value except from his approbation.

On some occasions they are all summoned together to meet the pope on affairs of higher importance, as for the nomination of bishops, or the admission of new members into their body; and then the assembly is called a *consistory*. The full number of cardinals is 72, but there are always some hats left vacant.

The Catholic Church being essentially episcopal is governed by bishops, who are of two sorts, bishops in ordinary, and vicars apostolic. By the first are meant titular bishops, or such as bear the name of the see over which they rule, as the Archbishop of Paris, or of Tuam, the Bishop of Cambray, or New Orleans. The manner of appointing such bishops varies considerably. Where they are unshackled by the government, the clergy of the diocese meet in chapter, according to old forms, and having selected three names, forward them to the Holy See, where one is chosen for promotion. This is the case in England, Ireland, Belgium, and perhaps in the free states of America. In most countries, however, the election of bishops is regulated by *concordat;* that is, a special agreement between the pope and the civil government. The presentation is generally vested in the crown; but the appointment must necessarily emanate from the pope.

The powers of bishops, and the manner of exercising their authority, are regulated by the canon law; their jurisdiction on every point is clear and definite, and leaves no room for arbitrary enactments or oppressive measures. Yet it is of such a character as, generally considered, can perfectly control the inferior orders of clergy, and secure them to the discharge of their duty. In most Catholic countries there is a certain degree of civil jurisdiction allowed to the bishops, with judicial powers, in matters of a mixed character, as in cases appertaining to marriages, where a distinction between civil and ecclesiastical marriage has not been drawn by the legislature. Some offences connected with religion, as blasphemy or domestic immorality, are likewise brought under their cognisance.

In some places, chiefly those which are dependencies of England, as in Gibraltar, the Cape of Good Hope, and the East Indies, the bishops who superintend the Catholic Church and represent the papal authority, are known by the name of *vicars apostolic;* thus at Calcutta, the vicar apostolic of West Bengal is archbishop in partibus of Edessa. A vicar apostolic is however not necessarily a bishop. Generally, however, he receives episcopal consecration; and, as from local circumstances, it is not thought expedient that he should bear the title of the see which he administers, he is appointed with the title of an ancient bishropric now in the hands of infidels, and thus is called a bishop *in partibus infidelium*, though the last word is often omitted in ordinary language. A vicar apostolic, being generally situated where the provisions of the canon law cannot be fully observed, is guided by particular instructions, by precedents and consuetude, to all which the uniformity of discipline through the Catholic Church gives stability and security. The powers of a vicar apostolic are necessarily more extended than those of ordinary bishops, and are ampler in proportion to the difficulty of keeping up a close communication with Rome. Thus many cases of dispensation in marriage which a continental bishop must send to the Holy See may be provided for by a vicar apostolic; and other similar matters, for which these must consult it, could at once be granted by the ecclesiastical superiors of the Mauritius or of China. The nomination of vicars apostolic is solely with the pope. In America, in England, and some other places, the vicars apostolic have been replaced by bishops bearing the title of some town within their diocese.

The inferior clergy, considered in reference to the government of the Church, consists mainly of the parochial clergy, or those who supply their place. In all countries possessing a hierarchy, the country is divided into parishes, each provided with a *parochus* or *curate*, corresponding to the rector or vicar of the English Established Church; the curate in the English and Irish churches being only equivalent to the vicaire of France and the sotto curato of Italy. The appointment to a parish is vested in the bishop, who has no power to remove again at will, or for any cause except a canonical offence juridically proved. The right of presentation by lay patrons is, however, in particular

instances fully respected. In Italy the parish priests are generally chosen by competition; as upon a vacancy, a day is appointed on which the testimonials of the different candidates are compared, and they themselves personally examined before the bishop in theology, the exposition of scripture, and extemporaneous preaching; and whoever is pronounced, by ballot, superior to the rest, is chosen.

Under an apostolic vicariate, the clergy corresponding to the parochial clergy generally bear the title of *apostolic missionaries*, and have *missions* or local districts with variable limits placed under their care; but are dependent upon the will of their ecclesiastical superiors.

Besides the parochial clergy, there is a considerable body of ecclesiastics, who do not enter directly into the governing part of the Church, although they help to discharge some of its most important functions. A great number of *secular* clergy are devoted to the conduct of education, either in universities or seminaries; many occupy themselves exclusively with the pulpit, others with instructing the poor, or attending charitable institutions. A certain number also fill prebends, or attend to the daily service of cathedrals, &c.; for in the Catholic Church, pluralities, where the cure of souls exists, are strictly prohibited, and consequently a distinct body of clergy from those engaged in parochial duties, or holding rectories, &c., is necessary for those duties. Besides this auxiliary force, the *regular* clergy, or monastic orders, take upon them many of these functions. These institutions, however closely connected with the Church, may require a fuller explanation in their proper place. The clergy of the Catholic Church in the West are bound by a vow of celibacy, not formally made, but implied in their ordination as *sub-deacons*. This obligation of celibacy is only reckoned among the disciplinary enactments of the Church. The clergy of that portion of the Greek and Armenian Church which is united in communion with the see of Rome, may be married; that is, may receive orders if married, but are not allowed to marry after having taken orders. A similar discipline, if thought expedient by the Church, might be introduced into the West.

The only point concerning the government of the Catholic Church which remains to be mentioned, is the manner in which it is exercised. The most solemn tribunal is a *general council*, that is, an assembly of all the bishops of the Church, who may attend either in person or by deputy, under the presidency of the pope or his legates. When once a decree has passed such an assembly, and received the approbation of the Holy See, there is no further appeal. Distinction must be, however, made between *doctrinal* and *disciplinary* decrees; for example, when in the council of Trent it was decreed to be the doctrine of the Church, that marriage is indissoluble, this decree is considered binding in the belief and on the conduct, nor can its acceptance be refused by any one without his being considered rebellious to the Church. But when it is ordered that marriages must be celebrated only in presence of the parish priest, this is a matter of discipline, not supposed to rest on the revelation of God, but dictated by prudence; and consequently a degree of toleration is allowed regarding the adoption of the resolution in particular dioceses. It is only with regard to such decrees, and more specifically the one we have mentioned, that the council of Trent is said to have been received, or not, in different countries.

When a general council cannot be summoned, or when it is not deemed necessary, the general government of the Church is conducted by the pope, whose decisions in matters of discipline are considered paramount, though particular sees and countries claim certain special privileges and exemptions. In matters of faith it is admitted that if he issue a decree, as it is called, *ex cathedrâ*, or as head of the Church, and all the bishops accept it, such definition or decree is binding and final. The great difference between the Transalpine and Cisalpine divines, as they are termed, is whether such a decree has its force prior to, or independent of, the accession of the body of bishops to it, or receives its sanction and binding power from their acceptance. Practically there is little or no difference between the two opinions; yet this slight variety forms a principal groundwork of what are called the liberties of the Gallican church.

The discipline or reformation of smaller divisions is performed by provincial or diocesan synods. The first consist of the bishops of a province under their metropolitan; the latter of the parochial and other clergy under the superintendence of the bishop. The forms to be observed in such assemblies, the subjects which may be discussed, and the extent of jurisdiction which may be assumed, are laid down at full in a work of the learned Benedict XIV., entitled 'De Synodo Diœcesana.' The acts and decrees of many such partial synods have been published, and are held in high esteem among Catholics; indeed, they may be recommended as beautiful specimens of deliberative wisdom. Such are the decrees of the various synods held at Milan under the virtuous and amiable St. Charles Borromeo.

II. The *laws* of the Catholic Church may be divided into two classes, those which bind the interior, and those which regulate outward conduct. This distinction, which corresponds to that above made, between doctrinal and disciplinary decrees, may appear unusual, as the term *laws* seems hardly applicable to forms of thought or belief. Still, viewing, as we have done, the Catholic Church under the form of an organised religious society, and considering that it professes to be divinely authorised to exact interior assent to all that it teaches, under the penalty of being separated from its communion, we think we can

well classify under the word *law* those principles and doctrines which it commands and expects all its members to profess.

Catholics often complain that doctrines are laid to their charge which they do not hold, and in their various publications protest against their belief being assumed upon any but authoritative documents: and as such works are perfectly accessible, the complaint must appear reasonable as well as just. There are several works in which an accurate account is given of what Catholics are expected to believe, and which carefully distinguish between those points on which latitude of opinion is allowed, and such as have been fully and decisively decreed by the supreme authority of the Church. Such are Veron's 'Regula Fidei,' or Rule of Faith, a work lately translated into English, and Holden's 'Analysis Fidei.' But there are documents of more authority than these; for example, the 'Declaration' set forth by the vicars apostolic or bishops in England, in 1823, often republished; and still more the 'Catechismus ad Parochos,' or 'Catechism of the Council of Trent,' translated into English not many years ago, and published in Dublin. A perusal of such works as these will satisfy those who are desirous of full and accurate information regarding Catholic tenets, of their real nature, and show that the popular expositions of their substance and character are generally incorrect.

The formulary of faith, which persons becoming members of the Catholic Church are expected to recite, and which is sworn to upon taking any degree, or being appointed to a chair in a university, is the creed of Pius IV., of which the following is the substance:—

The preamble runs as follows: "I, N. N., with a firm faith believe and profess all and every one of those things which are contained in that creed, which the holy Roman Church maketh use of." Then follows the Nicene creed.

"I most steadfastly admit and embrace apostolical and ecclesiastical traditions, and all other observances and constitutions of the same Church.

"I also admit the holy scriptures, according to that sense which our holy mother the Church has held and does hold, to which it belongs to judge of the true sense and interpretation of the scriptures: neither will I ever take and interpret them otherwise than according to the unanimous consent of the fathers.

"I also profess that there are truly and properly seven sacraments of the new law, instituted by Jesus Christ our Lord, and necessary for the salvation of mankind, though not all for every one,—to wit: baptism, confirmation, the eucharist, penance,* extreme unction, holy orders,† and matrimony; and that they confer grace; and that of these, baptism, confirmation, and order cannot be reiterated without sacrilege. I also receive and admit the received and approved ceremonies of the Catholic Church, used in the solemn administration of the aforesaid sacraments.

"I embrace and receive all and every one of the things which have been defined and declared in the holy Council of Trent, concerning original sin and justification.

"I profess likewise that in the mass there is offered to God a true, proper, and propitiatory sacrifice for the living and the dead; and that in the most holy sacrament of the eucharist there is truly, really, and substantially, the body and blood, together with the soul and divinity, of our Lord Jesus Christ; and that there is made a change of the whole substance of the bread into the body, and of the whole substance of the wine into the blood, which change the Catholic Church calls *transubstantiation*. I also confess that under either kind alone Christ is received whole and entire, and a true sacrament.

"I firmly hold that there is a *purgatory*, and that the souls therein detained are helped by the suffrages of the faithful.

"Likewise, that the saints reigning with Christ are to be honoured and invocated, and that they offer up prayers to God for us; and that their relics are to be had in veneration.

"I most firmly assert that the images of Christ, of the mother of God, and also of other saints, ought to be had and retained, and that due honour and veneration are to be given them.

"I also affirm that the power of indulgences was left by Christ in the Church, and that the use of them is most wholesome to Christian people.

"I acknowledge the holy Catholic Apostolic Roman Church for the mother and mistress of all churches; and I promise true obedience to the Bishop of Rome, successor to St. Peter, prince of the apostles and vicar of Jesus Christ."

Then follow clauses condemnatory of all contrary doctrines, and expressive of adhesion to all the definitions of the Council of Trent.

It is obvious that this form of confession was framed in accordance to the decrees of that council, and consequently has chiefly in view the opinions of those who followed the Reformation. It would be foreign to our purpose to enter into any explanations of the doctrines here

* Under penance is included confession; as the Catholic sacrament of penance consists of three parts: contrition or sorrow, confession, and satisfaction.

† The clerical orders of the Catholic Church are divided into two classes, *sacred* and *minor* orders. The first consists of subdeacons, deacons, and priests, who are bound to celibacy and the daily recitation of the *Breviary*, or collection of psalms and prayers, occupying a considerable time. The minor orders are four in number, and are preceded by the *tonsure*, an ecclesiastical ceremony in which the hair is shorn, initiatory to the ecclesiastical state.

laid down, much less into any statement of the grounds on which Catholics hold them, as we purposely refrain from all polemical discussion.

Such is the doctrinal code of the Catholic Church; of its moral doctrines we need not say anything, because no authorised document could be well referred to that embodies them all. There are many decrees of popes condemnatory of immoral opinions or propositions, but no positive decrees. Suffice it to say, that the moral law, as taught in the Catholic Church, is mainly the same as other denominations of Christians profess to follow.

Of the disciplinary or governing code we have already spoken, when we observed that it consisted of the Canon Law, which, unlike the doctrinal and moral code, may vary with time, place, and accidental circumstances.

III. Our last head was the essential or constitutive principle of the Catholic Church. By this we mean that principle which gives it individuality, distinguishes it from other religions, pervades all its institutions, and gives the answer to every query regarding the peculiar constitution outward and inward of this Church.

Now, the fundamental position, the constitutive principle, of the Catholic Church, is the doctrine and belief that God has promised, and consequently bestows upon it, a constant and perpetual protection, to the extent of guaranteeing it from destruction, from error, or fatal corruption. This principle once admitted, everything else follows. 1. The infallibility of the Church in its decisions on matters concerning faith. 2. The obligation of submitting to all these decisions, independently of men's own private judgments or opinions. 3. The authority of tradition, or the unalterable character of all the doctrines committed to the Church; and hence the persuasion that those of its dogmas, which to others appear strange and unscriptural, have been in reality handed down, uncorrupted, since the time of the apostles, who received them from Christ's teaching. 4. The necessity of religious unity, by perfect uniformity of belief; and thence as a corollary the sinfulness of wilful separation or schism, and culpable errors or heresy. 5. Government by authority, since they who are aided and supported by such a promise must necessarily be considered appointed to direct others, and are held as the representatives and vicegerents of Christ in the Church. 6. The papal supremacy, whether considered as a necessary provision for the preservation of this essential unity, or as the principal depository of the divine promises. 7. In fine, the authority of councils, the right to enact canons and ceremonies, the duty of repressing all attempts to broach new opinions: in a word, all that system of rule and authoritative teaching which must strike every one as the leading feature in the constitution of the Catholic Church.

The differences, therefore, between this and other religions, however complicated and numerous they may at first sight appear, are thus in truth narrowed to one question; for particular doctrines must share the fate of the dogmas above cited, as forming the constitutive principle of the Catholic religion. This religion claims for itself a complete consistency from its first principle to its last consequence, and to its least institution, and finds fault with others, as though they preserved forms, dignities, and doctrines which must have sprung from a principle by them rejected, but which are useless and mistaken the moment they are disjoined from it. Be this as it may, the constitution of the Catholic Church should seem to possess, what is essential to every moral organised body, a principle of vitality which accounts for all its actions, and determines at once the direction and the intensity of all its functions.

To conclude our account of the Catholic Church, we will give a slight view of the extent of its dominions, by enumerating the countries which profess its doctrines, or which contain considerable communities under its obedience. In Europe, Italy, Spain, Portugal, France, Belgium, the Austrian empire, including Hungary, Bavaria, Poland, and the Rhenish provinces of Prussia, which formerly belonged to the ecclesiastical electorates, profess the Catholic religion as that of the state, or, according to the expression of the French *charte*, that of the majority of the people. In America, all the countries which once formed part of the Spanish dominions, both in the southern and northern portion of the continent, and which are now independent states, profess exclusively the same religion. The empire of Brazil is also Catholic. Lower Canada, and all those islands in the West Indies which belong to Spain or France, including the republic of Haiti, profess the Catholic faith; and there are also considerable Catholic communities in the United States of North America, especially in Maryland and Louisiana. Many Indian tribes, in the Canadas, in the United States, in California, and in South America, have embraced the same faith. In Asia there is hardly any nation professing Christianity which does not contain large communities of Catholic Christians. Thus in Syria the entire nation or tribe of the Maronites, dispersed over Mount Libanus, are subjects of the Roman see, governed by a patriarch and bishops appointed by it. There are also other Syriac Christians under other bishops, united to the same see, who are dispersed all over Palestine and Syria. At Constantinople there is a Catholic Armenian patriarch who governs the *united* Armenians, as they are called, large communities of whom also exist in Armenia proper. In the Indian peninsula, including Ceylon, the number has been estimated at 600,000; they are governed by thirteen vicars apostolic with episcopal consecration, being all of them bishops *in partibus*.

In China, Tonkin, and Cochin-China, likewise, the professors of the Roman Catholic faith are numerous. In Africa, the islands of Mauritius and Bourbon are Catholic, and all the Portuguese settlements on the coasts, as well as the Azores, Madeira, the Cape Verd, and the Canary Islands.

CATHOLIC EPISTLES is the name given to the Epistles of the Apostles James, Peter, John, and Jude. They are called Catholic,—that is, "universal," according to the original meaning of the word,—because they are addressed not to any particular Church or nation, like the Epistles of St. Paul, but to the faithful in general then scattered about the world. St. James addresses his Epistle to the twelve tribes that are scattered abroad, meaning the converted Jews in Judæa and other Roman provinces. St. Peter addresses his first Epistle to the strangers scattered throughout Pontus, Galatia, Cappadocia, Asia, and Bithynia. St. John addresses the second of his Epistles to the elect lady and her children, meaning the universal Church and its disciples; and Jude addresses his to the faithful in general.

CATOPTRICS. [Optics.]

CATTI, a people of Old Germany, who lived between the Rhine and the Visurgis (Weser), as far east as the borders of the Hercynian forest. Tacitus ('German.,' 30) describes them as a fierce, hardy, robust race, skilful in their mode of warfare, which partook more of the character of a regular campaign than of that of the predatory incursions of other German tribes. Unlike other German nations, whose chief strength lay in their cavalry, the Catti fought chiefly on foot. The Batavi were a tribe of the Catti, who left their native grounds on account of some domestic differences, and settled in the islands at the mouth of the Rhine. [Batavi.] The Catti, with the Cherusci, Tencteri, and others, fought against Drusus, who defeated them; but some years after they defeated Varus and destroyed his legions. In the reign of Tiberius, Germanicus, the son of Drusus, attacked the Catti with a large force, overran the country, and made a great slaughter of them, sparing neither the women nor the old men. (Tacitus, 'Annal.,' i. 55.) The Catti, however, continued in arms against the Romans for a long time after, and we find them under Vitellius aiding the revolt of Civilis, the Batavian chief. They afterwards quarrelled with their neighbours, the Hermanduri, by whom they were nearly exterminated. ('Annal.' xiii. 57.)

CATTLE. In its most extensive sense the word cattle denotes all the larger domestic quadrupeds, which are used for draught or food. In the usual acceptation of the word, it is confined to the ox. The rearing and feeding of cattle is a very important branch of agricultural industry. Much of the success of a farmer depends on the judicious management of live stock, without which his land cannot be maintained in a proper state of fertility. The breeding and fattening of cattle are generally distinct occupations. It is of the greatest importance to the breeder, as well as to the grazier, to ascertain the qualities of each different breed of cattle; to determine which is best suited to his purpose, and which will bring him the greatest profit.

The domestic bull and cow are probably of Asiatic origin. In those countries where they are now found in a wild state, they are evidently descended from domestic animals which have been let loose, or have strayed from the habitations of man. The *Urus*, which ranged wild in the Hercynian Forest, and was a dangerous enemy to those who encountered him, appears to have differed little from the common bull. If he was the indigenous wild animal, he was perhaps the original stock, from which our different European varieties sprung, modified by climate and difference of pasture. This, however, is denied by naturalists, who consider him a distinct species. [Bison.] The small Hindoo ox with a hump on the chine, and the African Cape ox, which is used for riding as well as draught, and has no hump, are both more nearly allied to the buffalo. They are very tame, and more intelligent than the generality of our oxen, owing probably to their being more nearly associated with their masters. Of the cattle on the continent of Europe, one of the principal breeds is the Polish or Ukraine. The oxen of this breed are large and strong, and fatten readily in good pastures. Their flesh is succulent and well-tasted; but the cows do not readily allow themselves to be milked, and consequently are not fit for the dairy. The colour is generally a light gray, seldom either black or white. They are docile when worked, but are not considered so hardy and strong as the Hungarian oxen, which resemble them in colour, but are more compact, and have shorter limbs. The horns are large and spreading, which gives them a formidable appearance, and compared with the more improved and carefully bred cattle, they are heavy and coarse. When they are stalled in winter on hay and roots, they bring a considerable profit by fattening very soon. They are driven in herds from the extensive plains in which they are bred, and sold to graziers in the adjoining districts of Germany.

In the plains of Jutland, Holstein, and Schleswig, there is a very fine breed, with small short crooked horns, which appears to be nearly allied to the Friesland and to our own Holderness breed. They are of various colours; but mouse or fawn colour, interspersed with white, are the most common. Red cows of this breed are seldom seen. They are good milkers in moderate pastures, and the oxen fatten readily when grazed or stall-fed at a proper age. They are fine in the horn and bone, and wide in the loins; but they are not considered so hardy

and strong for labour as the preceding breed. If prejudice did not make the breeders select the calves with large bone and coarse features to rear as bulls, in preference to those which resemble the cows, this breed would soon equal our best short-horns. The cows are frequently fattened while still in milk, and are fit for the butcher by the time they are dry; the same system is followed by the great milkmen in the neighbourhood of London, with their large Holderness cows. This breed is much esteemed in all the northern parts of Europe. The Friesland, Oldenburg, Danzig, and Tilsit cattle are mostly varieties of this short-horned breed.

Towards the Alps the cattle have a different character; they are strong and active, and can range wider in search of pasture. The largest and finest breed is the Swiss, especially the Freyburg race, which is found in the rich pastures between the mountains in the neighbourhood of Greyerz (Gruyères), a place well known for its excellent cheese, which is consumed all over Europe. The cows, which are here the principal object of attention, are large and wide in the flanks, and strong in the horn (we should rank them in England among the middle-horns), short and strong in the bone, with a prominence at the root of the tail, which, according to our notions, would be considered a great blemish. They give abundance of rich milk when ranging in their native Alps, or when stalled and fed with clover or lucern in the stables. The oxen work well, but are rather heavy and slow. When fed off they fatten well; and although fat meat is not much prized there, some carcases may be seen slaughtered in Bern and Freyburg which are equal to those in the best English markets.

There is a smaller, but very active mountain breed of cattle in the Jura, which does well on scanty food. The cows are small and slight, generally of a light red colour. The oxen are very active and strong for their size. They draw invariably by the horns. They are not considered so profitable for stall feeding as the larger, but they are excellent for the small cottagers on the borders of the mountains, and find their sustenance among the woods and rocks, where they climb like goats.

The Norman breed gives the character to all the cattle usually met with in the northern part of France, except near the Rhine. They are mostly of a light red colour, sometimes spotted with white. Their horns are short, and stand well out from the forehead, turning up with a black tip; the legs fine and slender; the hips high, and the thighs thin. The cows are good milkers, and the milk is rich. They are in general extremely lean, which is owing in a great measure to the scanty food they gather by the sides of roads, and along the grass balks which divide the fields. In Normandy itself they have good pastures, and the cattle are larger and look better. The Alderney and Jersey breeds, which from the extreme richness of their milk are much prized in gentlemen's dairies in England, are smaller varieties of the Norman, with shorter horns, more turned in, and a still more deer-like form.

The Italian breeds are not very remarkable, except from the immense length of the horns of some of them. No great pains are taken to improve them, except in some parts of the north of Italy, where the Parmesan cheese is manufactured: there they resemble the Swiss breed, and are probably only varieties of the same stock.

The different British and Irish breeds have have been generally distinguished from each other by the length of the horn. The long-horned breed is supposed by many to be indigenous. Others consider the middle-horned as the old breed. The former was chiefly found in a district of Yorkshire called Craven, and was greatly improved by the skill of Robert Bakewell, of Dishley Farm, in Leicestershire, and hence they are called the Dishley breed. The distinguishing character of this breed are long horns growing downwards from the side of the head and ending in straight points parallel to the jaw. In order to give an adequate idea of the qualities of this improved breed, we must consider what breeders and graziers call the fine *points* of an ox. These are certain forms and appearances, which are either anatomically connected with a perfect conformation of the body, and especially of the organs of respiration and of digestion, or which are so constantly associated with the peculiar qualities of certain breeds, as to be proofs of their purity. Of the first kind are a wide chest, well formed barrel, strong and straight spine, hip bones well separated, and length of quarter, all which can be proved to be essential to the perfect functions of the body. Small and short bones in the legs give firmness without unnecessary weight. A thick skin well covered with hair ensures proper warmth, and its soft loose feel indicates a good coat of cellular substance underneath, which will readily be filled with deposited fat. All these are indispensable points in an ox which is to be profitably fatted, and whatever be the breed, they will always indicate superiority. Other points, such as colour, form of the horns, of the head, and extremities, the setting on of the tail, with other particulars, are only essential in so far as experience has observed them in the best breeds, and as they are indications of pure blood. The eye is of great importance; it should be lively and mild, indicating a healthy circulation, with a gentle and almost indolent temper. An animal that is not easily disturbed will fatten rapidly, while one that is restless and impatient will never acquire flesh. Amongst the ancients, a deep dewlap was considered as a great beauty in an ox. In some of our best breeds there is scarcely any. The rump of the Freyburg cows, as we observed before, rises high towards the tail; while a straight back from the neck to the tail is indispensable in a well-bred British ox.

Having established a breed which has many superior qualities, attention is paid to maintain its purity; and to those who cannot ascertain the parentage, certain marks are satisfactory proof of purity of blood. The new Leicester long-horn oxen were noted for the smallness of the bone and their aptitude to fatten. Their flesh was fine-grained, the fat being well intermixed in the muscles. At the time when Bakewell died, about 1795, no other breed could be brought into competition with his improved long-horns. But whether his successors have not paid the same attention to keep up the qualities of the breed, or it has degenerated in comparison, they have since lost much of their reputation, and the short-horned breed has now the superiority. Good long-horned cattle are, however, occasionally seen in the midland counties. One defect of the breed was, that the cows gave but little milk, and this may be the reason for now preferring the short-horns. The Teeswater or Holderness breed of cattle was produced by the importation of cows from Holstein or Holland, and careful breeding and crossing. They now much excel the original stock. The principal improver of the Teeswater breed was Mr. Charles Collins. By his care a breed has been produced which is unrivalled for the dairy, and for fattening readily. Almost every good breed now in existence traces its pedigree to his bulls, especially one of the first he used, called *Hubback*. The famous ox exhibited fifty years ago, under the name of the Durham ox, was of this breed. By careful crossing with a Galloway cow, an improved breed was produced, which was in such repute that at a sale of Mr. Collins's stock of short-horns, October 11, 1810, a famous bull, called Comet, sold for 1000 guineas, and 48 lots of bulls, cows and calves realised 7115*l.* 17*s.* Subsequent sales have proved that the estimation in which the breed is held has not fallen since Charles Collins's time. Thus the late Earl of Ducie's herd a few years ago, fetched 9361*l.* 16*s.* for 62 head, or 150*l.* 19*s.* a piece; and though so large a price cannot be quoted in any other case, yet every year there are sales at which bull and heifer calves fetch upwards of 100*l.* The short-horn cattle are mostly light coloured, some quite white, but most are speckled with red and white, without any large distinct spots. The horns are very short. In the cow, the points turn inwards towards each other. Some of the finest bulls have merely a tip of a horn standing out from each side of the forehead. In the carcase they have every point which we have before enumerated as essential to perfection.

Besides the two breeds above mentioned, there are several in great repute in particular districts, which almost dispute the superiority with the short-horns. Of these the Devonshire breed is the handsomest. The colour of this breed is invariably red, with a very fine head, small bone, and glossy hide. The oxen, although not so heavy as some, are the best for the plough on light lands; they walk nearly as fast as horses, and will work almost as well in pairs. The cows are good milkers, any deficiency in quantity being made up by the richness of the cream. The oxen fatten readily, and their flesh is of the best quality.

The Sussex breed is only distinguished from the Devon by being rather stronger, and not so fine in the head and horn.

The Herefordshire breed is larger and heavier than either of the preceding, the horns longer and more turned outwards; the colour is red, but the belly and the face are generally white, and there is often a white stripe along the back. This breed has many excellent qualities, and fattens well; but the cows are of little use for the dairy, from the small quantity of milk they yield. The Herefordshire oxen are best suited to the rich pastures of their native county, where they grow to a great size and increase fast. These are the principal English breeds. Of the Welsh breeds, the Glamorganshire cows are in good repute for the dairy; they are of a dark brown or black colour with a white stripe along the back, long white horns pointing rather forwards and upwards; the tail is set on rather high above the back, which is thought a defect, but in this they are much exceeded by the Freyburg cows mentioned above, which have great merit notwithstanding. The other Welsh breeds are distinguished chiefly by their hardy constitutions, which they owe to their having been bred in mountainous districts. Great droves of them come to all the English fairs; their low price and small expense of keep render them an object worthy the attention of cottagers and small farmers; they are best calculated to run on rough heaths and commons.

The principal indigenous Scotch breeds are the West Highland, the Galloway, the Angus, and the Shetland. There is a doubt whether the Ayrshire should be classed amongst the pure Scotch cattle. Their great resemblance to the short-horn in all but the size leads one to suppose that they are a cross of a smaller breed by a short-horn bull, but they have very good qualities, and are excellent for the dairy or for stalling.

A great many cattle are bred in the various islands which lie on the western coast of Scotland. They are mostly of a small black or dun-coloured breed, called Kyloes. They are very hardy, and when brought into good pasture, fatten rapidly, and produce the finest and best-flavoured beef. They are found in the greatest perfection in the Isle of Skye, and are sent annually in large droves from their native islands, and dispersed through Scotland and England. They are particularly in request in Norfolk, Suffolk, and Essex, where they are wintered on

turnips, and sent to Smithfield in the spring and summer following. If they do not produce so great a weight of beef as many other breeds, they always bring the highest price in the market, and require but a very short time to get fat. The Galloway is a peculiar breed, which has many good qualities; it has no horns; the body is compact, and the legs short; and few breeds can vie with the Galloway oxen and heifers in aptitude to fatten. There is a peculiar roundness in all the parts of the body, which makes the animal look well in flesh, even when he is lean. The skin is loose, and the hair soft and silky to the touch. They are mostly black, but some are of a dun colour, which shows a connection between this breed and the polled Suffolk. It is only the colour which distinguishes them. Many of the Galloway heifers are spayed, and get very fat at an early age. The Galloway cows are not very good milkers, in which respect they differ from the Suffolk, but their milk is very rich.

The *Angus* is also a polled breed, and has been long in repute. It is probably a variety of the Galloway, to which it bears a strong resemblance, than which it is larger and coarser, but it has been found in Angus from time immemorial.

The Shetland cattle are very diminutive and coarsely shaped, but their flesh is reckoned well flavoured. They are seldom driven into England or the South of Scotland, because when fat they attain but a very small weight. The breed is, however, worth the notice of experimental agriculturists.

The Aberdeenshire and Fifeshire breeds are horned, and have been produced by various crosses with short-horns and other English breeds. All the Scotch breeds have been greatly improved by the premiums given by the Highland Society for the encouragement of breeding.

Of Irish cattle, the small Kerry cow seems to be purely native. It is a useful breed for cottagers, requiring but moderate keep and care, and giving a considerable quantity of milk in proportion to the size of the animal and the food it requires.

Irish cattle are becoming rapidly improved by crosses with the short horn breed, of which numerous herds now exist in that country. They have hitherto been more affected by crosses with the improved Leicester long-horns.

These are the principal breeds of cattle in the United Kingdom. By selecting those which are best suited to each situation and pasture, the industrious farmer may add considerably to his profits, and at the same time enrich his land with the manure. In purchasing cattle it is very necessary that the age should be readily ascertained; the surest mode of doing this is by examining the teeth. A calf has usually two front teeth when he is dropped, or they will appear a day or two after his birth; in a fortnight he will have four, in three weeks six, and at the end of a month eight. After this, these milk-teeth, as they are called, gradually wear and fall out, and are replaced by the second and permanent teeth. At two years old, the two middle teeth are replaced; the next year there will be four new teeth in all; at four years there are six permanent teeth, and at five the whole eight are replaced. The milk-teeth do not always fall out, but are sometimes only pushed back by the second set; and in this case they should be removed with an instrument, as they impede mastication and irritate the mouth. The periods of their appearance are, however, affected like other evidences of growth and maturity by the earlier precocity of well-bred stock; and the following table, taken from Professor Simonds (Vol. xv. 'Journal of the English Agricultural Society'), represents the difference in this respect between mongrel and well-bred cattle.

DENTITION OF THE OX.

Table of early Average. The breed, &c. Favouring Development.			Table of late Average. The breed, &c. Retarding Development.		
Years.	Months.		Years.	Months.	
1	9	Two permanent incisors.	2	3	Two permanent incisors.
2	3	Four ,, ,,	2	9	Four ,, ,,
2	9	Six ,, ,,	3	3	Six ,, ,,
3	3	Eight ,, ,,	3	9	Eight ,, ,,

After six years old the edges of the teeth begin to wear flat, and as they wear off the root of the tooth is pushed up in the socket, and the width of the teeth is diminished, leaving interstices between them; this begins in the middle teeth, and extends gradually to the corners. At ten years old, the four middle teeth are considerably diminished, and the mark worn out of them. After fifteen years of age, few cows can keep themselves in condition by pasturing; but they may continue to give milk, or be fattened by stalling and giving them ground food. Horned cattle have rings at the root of the horns, by which the age may also be known. The first ring appears at three years of age, and a new one is formed between it and the skull every year after. But this mode of ascertaining the age is not so sure as by the teeth, deception being much easier, by filing off the rings.

In order to learn by experience what breed of cattle is most profitable, it is very advantageous to weigh them occasionally, and note their increase. For this purpose several simple and ingenious weighing machines have been invented. Experience has shown the proportion between the saleable quarters and the offal, in different states of fatness; and tables have been constructed by which the net weight is found by mere inspection. Multiplying the live weight by 0·6, gives a near approximation to the neat dead weight in an ox moderately fat and of a good breed. When an ox is fat, his weight may be very

nearly guessed by measuring his girth immediately behind the fore legs, and the length from the tip of the shoulder to the perpendicular line which touches the hinder parts, or to a wall against which the animal is backed. The square of the girth in inches and decimals is multiplied by the length, and the product multiplied by the decimal ·238. This gives the weight of the four quarters, in stones of 14 lb. This rule is founded on the supposition, that there is a certain proportion between the net weight of the quarters and that of a cylinder the circumference of which is the girth, and the axis the length taken as above. The proportion has been ascertained by observation and repeated comparison.* The measurement will at all events indicate the proportional increase during the period of fattening.

Cattle are not subject to many diseases, if they have plenty of food and good water, and are kept clean. Air is essential to them, and although cows will give more milk, and oxen will fatten better when kept in warm stalls in winter, they are both less subject to diseases when they are kept in open yards, with merely a shelter from the snow and rain. Epizootic diseases, which sometimes ravage whole districts, are less known in England than in most countries. For the peculiar diseases of cattle see Ox and Cow.

The most economical mode of feeding cattle is evidently by allowing them to seek their food on commons and uncultivated pastures; but it is only in particular situations that it is the most advantageous. Cattle fed on commons add little to the stock of manure, except when they are kept in the yards or stalls in winter: even then their dung is of little value, if they are merely kept alive on straw or coarse hay, as is generally the case where the stock is kept on commons or mountains in summer. When they feed in inclosed and rich pastures, their dung falling in heaps on the grass does more harm than good. The urine fertilises the soil in wet weather when it is diluted; but in dry weather it only burns up the grass. If we calculate what would be the amount of dung collected if the cattle were kept in yards or stables, and fed with food cut for them and brought there, and also the loss of grass by treading on the pastures, we shall have no doubt whether the additional labour of cutting the grass and bringing it home daily is not amply repaid by the saving. But if we also take into the account the variety of artificial grasses, pulse, and roots which may be grown with advantage on land unfit for permanent grass, and the quantity of arable land which may thus be kept in the highest state of cultivation, we shall be convinced that the practice of those countries where the cattle are constantly kept at home is well worthy of imitation. It may be of use to the health of the animals to be allowed to take a few hours' air and exercise in a pasture near the stable; but there is no advantage in their having any grass crop there: on the contrary, the barer of grass the surface is, the better. They will relish their food better when they are taken in after a few hours' fasting. A bite of fresh short grass might, on the contrary, give them a dislike to their staler food. When cut grass is given to cattle in the stalls, it is best to let it lie in a heap for at least twelve hours before it is given to them. It heats slightly, and the peculiar odour of some of the plants, which oxen and cows are not fond of, being mixed with that of the more fragrant, the whole is eaten without waste. Experience has shown that many plants which cattle refuse in the field, where they have a choice, have nutritious qualities when eaten mixed with others in the form of hay. There are few deleterious plants in good grass land or water meadows, and these are readily distinguished and weeded out. The quantity and quality of the dung of cattle stalled and well fed is so remarkable, that its value makes a considerable deduction from that of the food given; especially of green food, such as clover, lucern, tares, and every kind of leguminous plant. This supposes a sufficient quantity of straw for litter, and an economical collection of the liquid parts in proper reservoirs or tanks. In order to make the feeding of cattle advantageous, the buildings must be conveniently placed with respect to the fields from which the food is to be brought. Moveable sheds, with temporary yards, which can be erected in different parts of a large farm, according as different fields are in grass or roots, are a great saving of carriage, both in bringing the food to the cattle and carrying the dung on the land. A clay bottom should be selected, in a dry and rather high spot, if possible. But if permanent buildings for cattle, constructed of rough materials and thatched with straw, were erected in the centre of about forty acres of arable land, in different parts of a large farm, it would probably be a great saving in the end.

Good water is most essential to the health of cattle, and that which has been some time exposed to the air seems the best for them. When they are fatted in stalls on dry food, they should always have a trough of water within reach. A piece of rock-salt to lick, or some salt given with their food, is highly conducive to their health, and will restore their appetite when it begins to flag. Rubbing the hide with a wisp of straw or a strong brush, as is done to horses, may appear a useless labour, but it is well known that there is no better

* If g be the girth and l the length taken as above, a the area of a circle whose circumference is unity, then $l\,g^2\,a$ = cylinder; and if the proportion of this cylinder has been found by repeated trials to be the weight of the carcase in stones of 14 lb. as b : 1, then $l\,g^2 \times \frac{a}{b}$ is the net weight. In this case $\frac{a}{b}$ has been found = 0·238. $\therefore\ l\,g^2 \times 0{\cdot}238$ is the weight.

substitute for that exercise which is essential to health. Where labour is not regarded, as is always the case when the owner of the cattle attends upon them himself, the curry-comb and the brush are in regular use, and the advantage is not denied.

In those countries where the farmer is allowed to distil a spirit from his grain, it is a great advantage to an agricultural establishment to have a distillery attached to it, especially in a remote situation: and not only is the fattening of cattle on the refuse of the distillation a source of profit, but the manure extends fertility around. The produce in spirits and in cattle is easily transported to a great distance, and almost the whole of what is produced by the land returns to it in the shape of manure. The same may be said of the manufactory of sugar and spirit from beet-root, which has been lately so much extended in the north of France.

It can never be too much impressed upon the minds of agriculturists, that without dung there is no corn; without cattle there is no dung. Every means should therefore be used to encourage the breeding and feeding of cattle, and none can be more effectual than to show that the profits of a farm are always proportioned to the quantity of cattle kept, and the abundance of the food provided for them.

CAUSATION, CAUSE. The word *cause*, in Latin, had more nearly the sense of the Italian *cosa*, *thing*, than that which it now has in English. In the logic of the middle ages it was used in four senses, and these senses show that *causa* was not one limited word, though some sort of notion of *producing* runs through them all. There was the *material* cause, the very substance of the thing produced, certainly a *sine quâ non*: the *formal* cause, the particular arrangement under which the thing is what it is, and not another variation of the same matter: the *efficient* cause, the word cause in our English sense: and the *final* cause, the end or object of the existence of the thing. We still draw the distinction between efficient and final cause: but many readers hardly understand this definition; they may carry it with them in one sentence: the existence of disease is the efficient cause of the College of Physicians, the cure which is desired is the final cause.

The subject of causation is one of the darkest in metaphysics. Causation signifies etymologically the *action* of a cause in producing an effect. "The theory of causation ('Essai sur la Psychologie,' Paris, 1826) necessarily supposes three indispensable conditions: 1st. Two objects (agent and patient); 2ndly. Three changes (that of the agent; reason of the effect—that of the patient; effect of the action—that which the patient produces on the agent; effect of reaction); 3rdly. Four distinct moments (that which precedes the action—that in which the action begins—that of the reaction—and that after the reaction.)" The subject of causation has always been one on which the most subtle thinkers have exerted their powers of analysis; but, as in every similar research after final principles which cannot by any effort of the understanding be clearly discerned and defined, opinions remain still as conflicting as when the inquiry first began. The student, in wandering through the mazes of metaphysical dogmatism, is disposed to turn from a subject on which so much has been said and so little determined: he finds that the statements of writers consist either of that which every one already knows, or of that which no one can at all understand. It appears to be agreed that, though in every instance we actually *perceive* nothing more than that the event, change, or phenomenon B always follows the event, change, or phenomenon A, yet that we naturally *believe* in the existence of some unknown *quality* or *circumstance* belonging to the antecedent A, in virtue of which the consequent B always has been, is, and will be produced. The fact of magnetic attraction is usually adduced in illustration of causative influence; and the inquiry, *why* does the magnet move the iron? suggests the idea of that quality which is denoted by the word *power*; about the nature of which metaphysicians have always disagreed, and their dispute remains still unsettled. It is this attributed *efficiency* in the uniform antecedent of a change which philosophers have considered as forming the *relation of cause and effect*; and their endeavour to express the conception of this hypothetic quality has occasioned the employment of a great variety of terms, as energy, faculty, influence, capacity, ability, virtue, force, possibility, fitness, aptitude, &c. The following citations and references may be serviceable to those who desire to examine the learning of the subject. An account of the ancient division of causes into efficient, material, final, and formal, with all the subtleties of the Peripatetic school, is given in Lord Monboddo's 'Ancient Metaphysics,' 4to. vol. i. pp. 33-311; vol. ii. p. 212; and as a choice specimen of the later scholastic doctrine and categorical arrangement of causes, see 'Methodus cognoscendi Caussas,' auctore Thom. Isacio, 12mo., 1650. "*Causæ* et effectui respondent *potentia* et actus—illæ eædem sunt res." (Hobbes, 'Opera Philos.' c. ix., 'De Causa et Effectu.') The following discrimination is important: "Potentia agentis et causa efficiens (c. x. 'De Potentia'), idem sunt re, differunt autem consideratione; *causa* enim dicitur respectu effectûs jam *producti*, *potentia* vero respectu ejusdem effectûs *producendi*; ita ut causa *preteritum*, potentia *futurum* respiciat"—"All conception of future (*Ibid.*, 'Hum. Nat.') is conception of *power* able to produce something—we so far conceive that anything will be hereafter as we know that there is something at present that hath power to produce it; and that anything hath power to produce another thing hereafter, we cannot conceive but by remembrance that it hath produced the like heretofore—power simply is the

excess of the power of one (the agent) above that of another (the patient)." "The idea of *power* (Locke, b. ii., c. 21, 'Of Power') is that of *possibility*, faculty, ability to make any change—all power relates to *action*—power is not the agent, but the *relation* (of an object to its future action)—how mind excites motion by the *power* of thought, and how body communicates motion by the *power* of impulse, we are equally in the dark (c. xxiii.)—to have the idea of cause and effect it suffices to consider any thing as beginning to exist by the operation of some other, without knowing the *manner* of that operation (c. xxvi. 'Of Cause and Effect,' and see c. xxv. 'Of Relation')."

The far-famed and much disputed, though not original, opinions of Hume, which, with some slight modification, have been adopted by Dugald Stewart, Dr. Brown, and others, are contained in sec. 4, 5, 6, 7, 8, 11, of his 'Philos. Essays.' from which the following passages are taken. Consistency is not to be looked for in essays professedly *paradoxical*, and designed less for the development of truth than as ingenious specimens of the dialectic art. "We *suppose*," says Hume, "there is a connection between cause and effect; a *power* in the one by which it infallibly *produces* the other—power is that circumstance in the cause by which it is enabled to *produce* the effect—when we consider the *unknown* circumstance of an object by which the degree or quantity of its effect is fixed and determined we call that its *power*—the effect is the measure of the power—the utmost scrutiny can never discover but one event following another, without being able to comprehend any *power* by which the cause operates—no rational philosopher has ever pretended to assign the *ultimate cause* of any natural operation, or to show the action of that *power* which *produces* any effect; these ultimate principles are totally shut up from human inquiry—the *power* of the will in effecting animal motion is unknown and inconceivable; we are ignorant how bodies act on bodies, and how mind acts on itself and on body; it is a thing entirely incomprehensible—we have no idea of power at all: it is a word absolutely without any meaning either in philosophy or common life—were our *ignorance* therefore a good reason for rejecting any thing, we should deny all energy in the Supreme Being as much as in matter; experience only teaches us how one event consequently *follows* another, without instructing us in the secret connection which binds them together; we know nothing more of causation of any kind than merely the constant conjunction of objects: all events seem entirely loose and separate; one follows another, but we never can observe any tie between them: all we know of the matter is, that a cause is that *after* not *by* which anything constantly exists—it is an object *followed* by another, and where all the objects similar to the first are followed by objects similar to the second, or where *if the first had not been the second never had existed*—it is absolutely impracticable to *define* a cause without comprehending as a part of the definition a *necessary connexion* with its effect—belief of similar effects from similar causes is a natural instinct which reasoning can neither produce nor prevent." From observations so full of at least apparent contradiction, it is not surprising that both the denial and admission of the principle of causative power are imputed to their author by different writers. Many of the works written in refutation of Hume contain ingenious remarks, though little of discovery. Beattie 'On Truth,' c. v.; Oswald; Priestley. By Dr. Reid, Hume's opinion of *power* as having no objective reality beyond the imagination, is strongly opposed. ('Intellectual Powers,' 1827, pp. 440—459.) "The notion of power, it is said, is one of our earliest abstractions, a notion the most explicit and universal, for the expression of which all languages have distinct and appropriate words." The remarks of Dr. Price ('Moral Questions,' p. 29) deserve attention: "What can *do* nothing—what is *fitted* to answer no purpose, has no *dependence*, *aptitude*, or *power*—can be nothing real—the whole meaning of *accounting* for a fact implies something in the nature of objects or events that connects them, a *fitness to influence* one another." Price, Reid, Newton, and most writers on the subject, agree that where there is no substance there is no power, that is, that all power is the power of something; but by Sir Wm. Drummond ('Academ. Questions,' 4to, p. 10) and some others, it is contended that "power is not an *attribute*, but an independent primary indemonstrable *principle*, the cause of all things: and that we can possess a notion of the *existence* of it, as of the *vis movendi*, without any notion of its *nature*." The opinions of Dr. Stewart on the subject are not remarkable either for novelty or consistency. ('Elements of Philos.,' vols. i. and ii.) "In every change we have an *irresistible* conviction of the operation of some *cause*—it is a law of our nature; the mental association of cause and effect is of a most indissoluble nature—the idea of *cause* or *power* necessarily accompanies the perception of change—the human mind surely has a natural bias to conceive things as somehow linked together; possessed of *powers* and *virtues* which *fit* them to produce particular effects: but that we have no reason to believe this, is evident on a moment's reflection—it is a prejudice." Along with this declaration is enforced the propriety of distinguishing physical from *final* or *efficient* causes, that is from those "powers and virtues" which are declared to have no existence. "There may be," says Dr. Stewart, "no *necessary* connection among any phenomena we observe; the doctrine of necessity depends upon the truth of the proposition that every change has a cause with which it is *necessarily* connected." But what is meant by necessary unless that which cannot be varied or avoided? And surely this may be predicated of human actions, if the laws of matter and mind are immu-

table, that is, if the course of nature does not change, but continues to proceed in its established order; for then, as the universe exhibits an uniformity of sequence in successive phenomena, or, in other words, consists of a series of uniform causes and effects, or *antecedents* and *consequents*, for the difference of name is quite unimportant, man *must*, in the nature of things, assuredly be the creature of circumstances, and *must* act as he is acted on.

The work of Dr. Thos. Brown, entitled 'An Enquiry into the Relation of Cause and Effect,' is well known as a specimen of superior metaphysical analysis. The main points of the theory it contains are given more concisely in one of Dr. B.'s Lectures, vol. i. p. 135, and a particular account of the work, with a notice of some objections to its doctrine, is given by the Rev. David Welsh in his 'Life of Dr. Brown' (p. 98 *et seq.*, and notes I and N in Appendix).

As this 'Enquiry' was originally designed expressly to vindicate and explain the theory of Mr. Hume, it cannot be expected to contain anything essentially or importantly different; and that it does not is evident on a comparison of the leading propositions. Dr. B. perfectly coincides with Hume in maintaining that the relation of cause and effect is not known *a priori*, but from experience; and that after experience it is not discoverable by *reason*, but is merely an object of *belief*—a notion arising from "an instinctive principle of faith." Hume's assertion, that the *sentiment* of this relation is derived from experience only of the *customary* conjunction of objects, and arises merely from the mental act of *transition* from one object to the other, is contradicted by Dr. Brown; but Hume in his paradoxical humour has often incidentally done this for himself. The proposition of Hume that, *as to our knowledge*, there is "nothing but one event or object *following* another," is that which Dr. B. reiterates throughout the 600 pages of his treatise, in showing that, "in a sequence of causes and effects, whether as to the phenomena of mind or of matter, there is absolutely nothing more than the antecedents and consequents themselves;" that the idea of power, when acutely analysed, is simply the idea of A itself, as that which invariably, and without the intervention of anything whatever, is followed by B: the relation of things as to *power* being, in fact, their relation as to *time*: and the question about cause and effect, a question solely about the uniform priority and posteriority of events in time. The idea of action, force, and energy is also resolved into that of simple antecedent and consequent: so that all is reduced, as Hume has it, to one thing, not *by* but *after* another. This identification of the idea of power with that of an antecedent having an invariable relation to a consequent, only as to *time*, has been regarded by many as virtually a denial of the reality of what is named casual power; but Dr. B., no less than other philosophers, appears to have the same vague conception of an indefinable something which, known only by its operations, constitutes at once a latent portion of the whole qualities of an object, and forms its efficiency to create a certain uniform change in another. He says that power is the relation of a particular antecedent to the uniform change that follows, and that he feels this relation to be a fitness or aptitude in the former to produce the latter. He says that "God formed objects with powers to be antecedents of changes;" that matter, like mind, is capable of beginning changes; and that we believe in the relation of cause and effect, "not because we can demonstrate it to ourselves or to others, but because it is impossible for us to disbelieve it; the belief being in every instance intuitive." But if proof be wanted that Dr. B. entertained an orthodox notion of power as a productive principle, it is given in the positive assertion of his personal friend and biographer, the Rev. Mr. Welsh (p. 131), who says, that were his theory of causation *really* deficient in this particular, instead of commending he should reject it as "a monstrous heresy." If this be so, it is amusing to see Dr. Brown reprimanding Dr. Reid for dealing in "a tissue of distinctions merely verbal," about "a mysterious unintelligible *something*." The truth is, that *power* is merely a name for human ignorance: the mind feels uneasy and dissatisfied in contemplating the unaccountable gap between an antecedent and consequent, and readily adopts any hypothesis that will put a bridge over it; hence the *power* of gravitation, the *power* of volition, &c. Dr. Brown's definition of cause as that which *immediately* as well as invariably precedes a change involves an obvious *petitio pincipii*: for the question is whether B really is immediate to A, as known to us? whether there exists a third co-efficient to causation? but this question can never be answered.

Of the numerous strictures which have appeared on the theory of Dr. Brown, we may notice the two following: 'An Essay upon the Relation of Cause and Effect, controverting the doctrine of Hume, Brown, and Lawrence,' 8vo, 1824. The author contends that antecedency and subsequency are not essential to the proper definition of cause and effect; because, although an object, in order to act as a cause, must exist antecedently to such action, yet that when it does act as a cause, its effects are synchronous with that action, and are included in it; that it is not mere sentiment, but reason (the faculty of perceiving the *ratios* of things), which produces the conviction that everything which begins to exist must have a cause; and which forces the mind to perceive that similar causes must necessarily have similar effects, that nature cannot, without a contradiction of terms, be conceived to alter her course, and therefore that no other change could ensue than that which, in any given instance, does ensue; and that we derive, from the observation of changes, and from the operation of

reason, the notion of that producing principle which we denominate *power*. In the translation, by Mr. Henry, of the 'Elements of Psychology,' by Victor Cousin, 1834, the theory of Hume and Brown is considered as asserting an unconnected succession of phenomena, without the admission of any idea of causative efficiency: some elaborate remarks of the translator, in accordance with the doctrine of the author, are therefore given to exhibit its "falsehood and fallacy." It is said that Dr. Brown confuses and mistakes the two distinctly different conceptions of *uniform antecedence* and *causation*; that he takes the former which is only a *condition* of the idea of causation, for the idea of causation itself, which includes something *more* and *different*, as proved by the consciousness of the relation of muscular motion to the act of volition, and by the usages of all languages, &c., that the idea of cause is that of a doer, actor, producer, changer, mover; and that the degree of motion produced is correspondent to the degree of causative power exerted. An exposition of the doctrine of causation adopted in the transcendental theory of Kant may be found in the article on philosophy by Thomas Wirgman, vol. xx. 'Encyclop. Londinensis' (see 'Causation' in Index, p. 252). By the Kantians the conception of the relation of cause and effect is considered as a synthetical judgment *a priori*—a postulate of pure reason. It is a remarkable fact in the history of metaphysical science, that the speculations of Hume on the idea of causation suggested to Kant the first notion of his system of transcendental ideas, that is, ideas which possess the character of universality and necessity. By Dr. Abercrombie, in his work on the 'Intellectual Powers,' 1832, the subject of causation is considered as belonging to those "first truths," any demonstration of which it is absurdity to attempt (pp. 187-208-214). The following citation is from a learned metaphysical work (Harpur 'On Philosophical Criticism,' 4to, 1810):—"All relation of necessity exists in some quality, property, or attribute which is common to the things related; if things be related as cause and effect, such relation must belong to the predicaments of action and passion: all action implies motion either of body or mind; it is *motion* therefore which, being communicated, is common to the two objects, and is that which constitutes the relation of cause and effect." It would be endless to enumerate works in which the subject of causation is discussed. The treatise of M. Maine de Biran on the relation of cause and effect is highly commended by Cousin. Many works on natural theology and free-will contain more or less on the subject—Hobbes, Clarke, Leibnitz, Collins, Hume, Butler, Cudworth, Edwards, Coplestone, &c.

CAUSE (in Natural Philosophy). We have here only to explain the manner in which this word is used, and not to enter into any speculation upon the connexion of cause and effect. In common language we say that *A* is the cause of *B*, when we have observed that *B* never appears without *A* having preceded, so that *A* is always followed by *B*. And, generally speaking, we are in the habit of assuming the phenomenon which comes first to be the cause, and that which comes afterwards, the effect. In natural philosophy, the word *cause* is used in two senses, which may be distinguished into *true* and *hypothetical*; and it is found convenient for distinction to latinise the former term into *vera causa*. 1. By a *vera causa*, or *true* cause, is meant that which is actually concerned in producing the effect. Thus the rotation of the earth is a *vera causa* in the production of day and night; and similarly, what we call attraction is a *vera causa* in the production of the celestial motions.

2. There are two different ways in which the word cause is used in the sense which we distinguish by the word *hypothetical*. (I.) The first is when we are able to prove that phenomena take place exactly in the manner and to the extent which would necessarily happen if a certain supposition were true; so that we cannot be led into error *as to results*, if we assume that supposition to be true. Thus the supposition of the stars being all fixed in an immense crystal sphere, which sphere is turned round from east to west, is one from which the apparent motions of the stars, such as they are, would necessarily follow, and, being frequently applied to the explanation of the details of the heavenly motions, is then assumed as an hypothetical cause. And when it is found that the motions of all the planets are precisely such as would take place if the sun attracted them all, and they each other, as implied in the word gravitation, then the attraction which is sufficient to produce the effects in question is assumed as an hypothetical cause. Thus in the old disputes about the motion of the earth, each side admitted that the other produced an unobjectionable hypothetical cause, and the point in question was, which had the *vera causa*. And formerly it was discussed whether gravitation was a primary quality of matter, or whether the intermediation of other matter was necessary. The second supposition involved the attempt to explain gravitation, by introducing some other quality of matter as the *vera causa*, in place of the hypothetical attraction. And the doctrine of immaterialism [BERKELEY, BIOG. DIV.] is an attack upon the notion of *matter* as a *vera causa* for the phenomena of the external world, though as an hypothetical cause it is admitted as an unobjectionable mode of speaking.

(II.) A phenomenon is cited as the hypothetical cause of another, when the two are always found together, and the nature and quantity of the second are connected by an invariable law with the nature and quantity of the first. In this sense we have seen, in the article CAPILLARY ATTRACTION, that because convexity and depression always go together, and also concavity and elevation, the depression is

referred to convexity, and the elevation to concavity, by the same sort of language as would be used if the first of each couple were the *vera causa* of the second. This is a language of convenience, but is apt to be misinterpreted.

Questions as to whether hypothetical causes are true or not, do not now occupy the attention of philosophers to the extent which was formerly the case. When the motions observed to exist in any system are sufficiently known, the pressures or other admissible species of action which would be sufficient to produce these motions are at once substituted as hypothetical causes. Thus, though the connexion between magnetism and electricity renders it an object of curiosity to trace them to some common hypothesis, few, we imagine, would attempt to find the *cause* of magnetism in the sense of the *vera causa*. It is otherwise when an hypothetical cause is found not to be sufficient to produce all observed effects. For example, the *undulatory* theory of light has prevailed over the *emission* theory, not because we have less reason to suppose that light is an emanation of particles from the sun and stars than existed a hundred years ago; but because it is found that many lately discovered facts are *not* such as would be true if light were an emanation, but *are* such as would be true if it consisted in undulations excited in an elastic medium. And though this cannot but favour the supposition that the undulations are the *vera causa*, yet that remains only a probability; the certainty is that the phenomena of reflexion, polarisation, &c., as hitherto observed, are all such as would necessarily follow, if the theory of undulations were true.

It must appear at first that this application of the word cause makes the ultimate end of natural philosophy much less imposing, if not less important, than the more common idea; which consists in supposing that the reasons (*verœ causœ*) of phenomena are discovered. But whether this be so or not, it is the only rational and demonstrable method of using the word. And it must be observed that all similar phenomena are thus, as it were, bound up together, and made to belong to one system. If then we refuse to say, with many popular works on physics, that "Newton was the first who found out *why* water runs down-hill," we conceive that we are not altogether without a substitute when we say, that Newton was the first who connected the motion of water down-hill with all the motions in the solar system in such a manner that any new information as to any one of them can be extended to all.

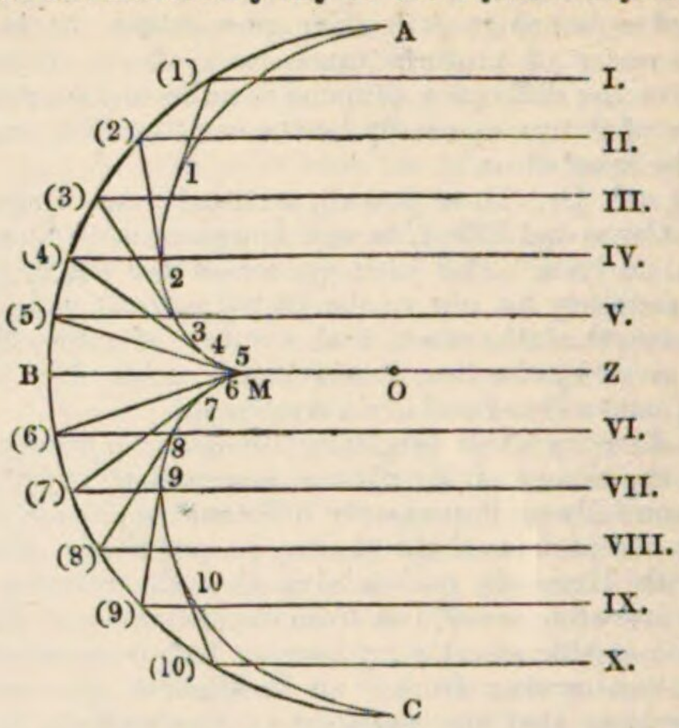
But the great use of hypothetical causes lies in this, that they tell us, as long as they last, what to look for. The cause being assumed, the application of mathematics points out the time or circumstances under which to look for new phenomena, or to look at old ones in a new light. Thus several phenomena with regard to light, which might have remained long unobserved, have been predicted by computation from the undulatory theory, and subsequently verified. And in the planetary system, several motions too small to be easily detected, except by a person who previously knows in what manner and at what time to watch for them, have been added by theory alone to the list, and verified by observation; and it is by such means that Neptune and some of the asteroids have lately been discovered.

The language of causation is sometimes misapplied in this way; the proof that a thing is, is called the reason why it is. Thus we remember seeing in the notes to Simson's edition of Euclid an assertion that geometry gives the reason *why* two sides of a triangle are greater than the third, whereas we never could detect anything more than the proof that they *are* so. Another misuse of the word has been pointed out by Dr. Reid. "In natural philosophy," he says, "when an event is produced according to a known law of nature, the law of nature is called the *cause* of that event. But a law of nature is not the efficient cause of any event; it is only the rule according to which the efficient cause acts." Hence, it is not right to say that the *cause* of the acceleration of force in gravitation is that bodies move towards each other with a velocity which varies inversely as the square of the distance.

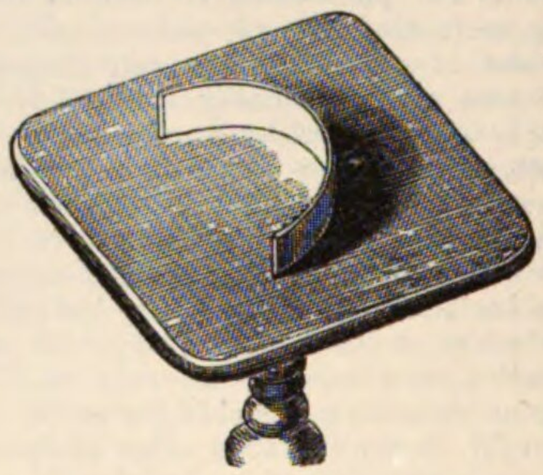
CAUSTIC. A term used in Pharmacy, chiefly to denote nitrate of silver (*lunar caustic*) and hydrate of potash. In chemistry it is applied as a prefix to the names of the alkalies and alkaline earths: thus we have caustic potash, soda, or ammonia, and caustic baryta, strontia, lime or magnesia; by which is understood, in the case of the alkalies, their compounds with water, and in the case of the alkaline earths, either the pure sustances themselves, or their compounds with water.

CAUSTIC (in Optics). When a number of rays proceeding from a point are reflected or refracted at or through any number of media, they will not, in most cases, be all thrown to the same point again, but will be dispersed in such a manner as to touch some curve or surface depending for its form and position upon the position of the luminous point, and the form and position of the reflecting or refracting surface. This curve is called the *caustic* of the surface. We will give a case of the most simple kind. A reflecting curve A B C of a semicircular form receives rays coming from a point on B O produced but at so great a distance, that they may be considered as parallels. The rays I, II, III, &c., strike the semicircle at (1), (2), (3), &c., and are then reflected in the directions (1)1, (2)2, (3)3, &c. The curve A M C, having a cusp at M, is constructed in such a manner that any ray whatsoever moving parallel to Z B, shall, after reflection at the circle, touch or graze this curve, which is therefore called the *caustic*

by reflection from parallel rays of the semicircle A M C. And the space A M Z will not be illuminated by any of the *reflected* rays coming from



any point on A B, but only by those which come from a part of B C, which, after touching C M, their branch of the caustic, proceed and cut through A M. The consequence is, that the space A M C B will be much more highly illuminated than the exterior space; an effect which may be rendered visible by placing a ring, with a bright interior surface, or a piece of steel spring highly polished, upon a table, in the sun-light. It will then become evident, by a part of the table within the ring, of



the form A M C B, becoming brighter than the rest, that the greater portion of the reflected light strikes the table within such a curve. Caustic curves are often well shown at the bottom of cylindrical vessels of china or earthenware, when favourably situated with respect to the sun or the light of a candle. In such cases the depth of the vessels causes the rays to fall too obliquely on their cylindrical surfaces, but by inserting a circular piece of card or white paper about an inch beneath their upper edge, or by filling them to that height with milk, the caustic curves can be finely exhibited. Caustics by refraction can be produced by exposing a glass globe full of water, such as the belly of a round decanter, to the rays of the sun, or the light of a candle, and receiving the refracted light on a sheet of paper held nearly parallel to the axis of the sphere, or in such a way that its plane may pass nearly through the luminous body. Under such circumstances there will be seen on the paper a luminous figure bounded by two bright caustics forming a sharp cusp or angle at the focus of refracted rays. These curves are evidently produced by the intersection of the rays, which being incident on the sphere at different distances from the axis, are refracted to foci at different points of the axis, and thus cross one another.

The point which it is of most importance to notice in relation to caustics is the following: It is usual to suppose, for the sake of convenience, that all reflected or refracted rays converge to a point. This is practically true; or rather we may say that such a number of rays are collected by mirrors and lenses so near to a point, that the effect of a complete convergence is produced. If we look at the diagram, we see that all the rays which enter between I and III are far from being nearly reflected to a point, but are scattered along the caustic from 1 to 3. But an equal number of rays entering between V and VI is collected between 5 and 6 on the caustic, very near to M. The consequence is, a sufficient convergence of rays near M to give a bright image of the luminous point whence the rays came, in the formation of which it is evident that only the parts of the mirror near B will be efficient. No curve except a parabola would, in the circumstances of the diagram, make every ray converge accurately to one point.

A complete theory of caustics would include that of telescopes and microscopes of every kind; but would be of no practical use, except so far as relates to the cusps and the part of the curve near them. These curves were first considered by Tchirnhausen, who gave them their name, and afterwards by John Bernoulli. They are much treated of in the older English works on optics, in a geometrical manner. The algebraical question, in its most general form, has been investigated by

Malus in his 'Théorie de la Double Réfraction,' Paris, 1810; and more recently by Professor Hamilton, in two papers on 'Systems of Rays,' published in the Transactions of the Royal Irish Academy. The question of EVOLUTES is nearly akin to that of caustics.

CAUSTICS. [ESCHAROTICS.]

CAVALIER was formerly an ordinary English term for a horse-soldier; but it has an additional and historical meaning by having been assumed by, or given to, the adherents of Charles I. in the civil war, to distinguish them from the *Roundheads*, the name given to the adherents of the Parliament.

CAVALIER, a work whose rampart is raised several feet above those of the fortress in which it is formed. It serves either to defilade those ramparts from the fire of an enemy on a neighbouring height, or to afford a plunging fire into the trenches of the besiegers. It is generally constructed on the terreplein of what is called a full bastion, and sometimes upon the rampart of a curtain; its form, on the plan, was originally semicircular, but the cavaliers in bastions are now built with straight faces and flanks parallel to those of the work in which they are placed.

A cavalier thus formed and situated is proposed by Cormontaingne as a retrenchment in a bastion. He recommends that on its exterior, along the two faces, there should be a ditch whose sides have revetments of masonry; and that the ditch should be defended by traverses connecting the faces of the cavalier with those of the bastion, near the shoulders of both. The great disadvantage of cavaliers is, that they take up the whole of the available space in a bastion, and crowd the defenders.

Trench cavaliers are works raised by the besiegers on the glacis of a fortress, in order to enable them to direct a plunging fire of musketry into the covered way. They are formed of successive steps, revetted with gabions in tiers above each other.

CAVALRY (remotely from the Latin *caballus*, 'a horse,') is that class of troops which serve on horseback; and, in the British army, it consists of the two regiments of Life Guards, the royal regiment of Horse Guards, seven regiments of Dragoon Guards, and eighteen regiments of Light Dragoons, of which the 7th, 8th, 10th, 11th, 15th, and 18th, are Hussars, and the 9th, 12th, 16th, and 17th are Lancers.

Among the ancients, while warfare consisted in expeditions to remote places rather for plunder than conquest, a numerous cavalry was indispensable. In proportion however as the art of war improved, this class diminished in value: the strength of the Greek and Roman armies lay chiefly in the firm array of their foot-soldiers, and Folard observes, that the most certain evidence of decline in the military character of a state is the existence of a numerous cavalry. A well-disciplined cavalry has however often turned the scale of fortune in war: cavalry contributed greatly to the conquests of Philip and Alexander, and the superiority of Scipio over Hannibal in cavalry was the cause of the victory at Zama. In modern times, Seidlitz gained by his cavalry the battle of Rosbach in 1757: and the victory at Wurzburg in 1796 was decided by the same arm.

In the early French monarchy, and in the Anglo-Saxon kingdoms of Britain, the men of wealth and noble birth distinguished themselves in the field from those of inferior rank by being well armed and mounted on horses. And during several centuries in which the poverty of the nations prevented princes from maintaining standing armies and when the foot-soldiers were men undisciplined and ill-provided, and summoned from the plough to attend the sovereign for a short time only, it is evident that a class of troops comprehending those men who, by the tenure of their estates, were required to serve in the wars at their own charges, and to bring into the field a number of dependents mounted like themselves, and trained in the daily practice of martial exercises, must have constituted almost the only efficient arm of battle.

In France the superior classes of these warriors bore the title of knights bannerets, and the others were designated knights of the second order, or bas-chevaliers. In those days the infantry, for the reason before-mentioned, being held in little estimation, the strength of armies was denoted by the number of banners and pennons under which the knights and their attendants fought; victories also were distinguished only by the number of men of rank who had been slain or made prisoners.

But the power of the nobles becoming too great for the monarch, and their mutual jealousies constantly involving the nation in the miseries of civil war, Charles VII., in 1445, took advantage of the temporary tranquillity which reigned in France after the English had been compelled to abandon nearly the whole of that country, to reduce his military force. From that time the kings retained in constant pay fifteen companies, as they were called, each consisting of 600 horsemen, besides the young men bearing the title of archers and pages, who also in general fought on horseback, but were clothed in a lighter armour. The troops composing the companies appear to have been what would now be called gentlemen; and the esteem in which they held themselves is evident from the refusal of the Chevalier Bayard, on the ground of their quality, to unite them with the Lansquenets (German infantry) at the siege of Padua, in an assault proposed by the Emperor Maximilian to be made on the place.

More than a century before the time of Charles VII., the English cavalry in the pay of the state was divided by Edward III. (1324) into small bodies, commanded by officers called constables; and Grose observes, that the list of the army at St. Quintin (1557) is the first in which a body of cavalry is distinguished by the appellation of a troop; a name which is still given to the half of a squadron, or the eighth part of a full regiment.

The respectability of the French companies above mentioned seems to have declined from about the time of Francis II., men of a lower grade being then occasionally introduced, from the difficulty, it is said, of filling with men of high birth the ranks, which were become very numerous.

But the employment of artillery in the field deprived this heavy-armed cavalry of all the advantages it possessed over the soldiers who fought on foot, and the latter were often enabled to maintain the combat after the horsemen were dismounted or forced to retire; hence they gradually rose in reputation, and the good discipline and conduct of the Swiss infantry in the Italian wars induced the French and Germans to augment the number of the troops of this class in their armies. From that time the cavalry, though always an essential arm in war, may be said to have been inferior in importance to the infantry.

It appears that light cavalry did not before the age of Louis XII. exist as a distinct body having general officers and a staff; but Montluc, in the reign of that monarch, mentions a general of 1200 light horse; and the corps must have subsequently become numerous, for it is said that Henry II., in 1552, had 3000 such troops under his command in his expedition to Germany.

The Dragoons are intermediate between heavy and light cavalry, trained to act either on horseback or on foot, as may be required. Père Daniel ascribes their formation to the Maréchal de Brissac, when he commanded the French armies in Piedmont at the end of the 16th century. The practice of horsemen fighting on foot is however very ancient: the Roman cavalry are said to have done so at the battle of Cannæ; and Procopius relates that one of the generals of Justinian, in an engagement with the Persians, caused his horsemen to dismount, and oppose their lances to the enemy's cavalry. Dragoons appear to have been introduced into the English service before the middle of the 17th century; but the oldest regiment of dragoons in the army is that of the Scotch Greys, which was raised in 1681. Dragoons perform the duty of advanced guards and patrols; they escort convoys, and harass the enemy in his retreat; or, in reverses, they protect the dispersed and defeated infantry. The *name* Dragoon arose from the weapon with which they were armed. [ARMS: *Dragon.*]

Hussars are also a species of light cavalry, which originally constituted the national militia of Poland and Hungary. In France they were formed into a corps in the time of Louis XIII., under the name of Hungarian cavalry; and the class of troops was subsequently adopted in this country. It is uncertain whence they obtained their present denomination, but probably from the shout they formerly gave before beginning action. They are now employed to protect reconnoitring and foraging parties, to serve as patrols, and to perform all the ordinary light cavalry duty.

The Lancers were introduced into the British service in order to correspond to the corps of what were called Polish Lancers in the French army. The long lances carried by this class of troops were supposed to be of use in a charge against infantry, and the fluttering of the flag at its extremity, by alarming the horse, to give an advantage over a dragoon otherwise armed.

In the last war with France, a portion of the French cavalry was furnished with cuirasses, and, in imitation of them, the English Life Guards have since borne the same heavy armour. These troops carry only a sword and a carbine; the heavy cavalry in general carry carbines and swords; and the light cavalry, with the exception of the Lancers, who besides the lance carry a sword and pistols, the same. The carbine with which the English cavalry is armed is a short breach-loading rifle. A complete regiment of cavalry is divided into four squadrons, and each of these into two troops. The full strength of a troop is 80 men; and to each troop there is appointed a captain, a lieutenant, and a cornet.

CAVEAT. As a general term in law, a caveat denotes a formal notice or caution given, by a party interested, to a court, judge, or public officer against the performance of certain judicial or ministerial acts. Thus caveats in this general sense were entered formerly in the Court of Chancery against the passing of a patent; and in the Court of Common Pleas against the levying of a fine. In a more confined and technical sense, a caveat signifies, 1. A caution entered in the Court of Probate to stop the granting of probates of wills or of administrations; and 2. A notice given to the bishop by a party who disputes a particular right of presentation, to prevent the institution of a clerk to a benefice. A caveat in the former case is for six months; in the latter binding for three; and an institution made, pending the caveat, has been considered as wholly void by that law. The effect of a caveat on the Court of Probate, is to entitle the person entering it to notice of any application for probate or administration, so that he may appear and oppose it (20 & 21 Vict. c. 77; 21 & 22 Vict. c. 95; 'Rules and Orders of the Court of Probate,' 1858).

CAVIAR (French, *Caviar, Cavia*; German, *Kaviar*; Italian, *Caviario, Caviale*; Spanish, *Caviario*; Russ. *Ikra*); an article of food prepared in Russia from the roes of some large fish, generally the

sturgeon. The greater part of the caviar is prepared near the mouths of the Volga, and also at the mouths of the Danube, Dnieper, and Don. In the month of March, the sturgeon arrives in great numbers for spawning at these places. The ovaria of the largest of these fish are estimated to contain 3,000,000 of eggs. The fish are caught both with nets and with hooks. Caviar is prepared by removing from the roe all its membranes; it is then washed in vinegar or white wine, and dried by being spread on a board in the air. After this, it is thoroughly salted, the salt being rubbed in with the hand; it is then put into a bag and pressed in order to remove the liquor; finally it is packed in kegs, and is then ready for sale. The caviar made on the shores of the Caspian is for the most part sent up the Volga to Moscow; that shipped from the ports of the Black Sea and Sea of Azof is bought at Astrakhan by the Armenians of Nakhitchivan and the Greeks of Taganrog. This caviar is not so good as that which is made on the Caspian. The principal exports are to Italy; very little is brought to England. The shipments altogether form only a small part of what is made, the consumption in Russia being very great in consequence of the three seasons of fasting which occur in the year. There has been known to be as much as 1000 cwts. of caviar shipped from Odessa in a single year; but this is far beneath the produce of the Caspian, which has in some years reached 15,000 cwts. When of good quality, caviar is dry and of a brown colour; it is commonly eaten with oil and lemon-juice. A cheaper and less prized kind is obtained from the roe of the gray mullet, and from some species of carp, which are common in and near the Black Sea.

Although not known by the name of caviar, there are several other articles of food similarly made from the roe of fish. One is called *botargo*, made on the coasts of the Mediterranean from the spawn of a species of mullet, especially at Tunis, and in Sicily; it is prepared nearly in the same way as caviar. In the islands of the Indian Archipelago, a considerable trade is maintained in the roe of a large species of chad or shad, found in the rivers of Sumatra. Some of the American Indians gather herring-roe as an article of food; at certain seasons of the year they sink cedar-branches to the bottom of a shallow river by means of heavy stones, and by the next morning the green foliage of the branches is found to be covered with herring-spawn; the Indians wash this off into a water-proof basket, squeeze it by the hand into little balls, dry it, and eat it as a very palatable food. Mr. Simmonds thus describes the mode adopted by the Spaniards of Central America in curing the roe of the callipera fish. "They first rub the roe well with salt and a little nitre, then they put a number of them one upon another, and compress them by means of a heavy weight. After this they build up a sort of stove of green boughs, covering the top with green branches intersecting each other. The inside being filled with straw and fresh leaves, they ignite these, place the roes on the top, and cover them well up with green boughs. The roes are allowed to remain six or seven days in this state, during which time the fire keeps smouldering and sending up a thick smoke; this smoke is concentrated on the roes by the upper layer of branches. The membraneous covering of the roe is not taken off; and thus, the air being excluded, the roe will remain good for a long time. When the roe is to be eaten it is cut in very thin slices; the outer coating is even then not taken off, but is rubbed clean with a dry cloth."

CEDAR-WOOD, OIL OF. The essential oil of cedar-wood contains *cedrole*, a crystalline solid, of the formula $C_{30}H_{28}O_2$, dissolved in a liquid hydrocarbon termed *cedrene*, and having the formula $C_{32}H_{26}$.

CEDRENE. [CEDAR-WOOD, OIL OF.]

CEDRIRET, one of the products of the distillation of coal tar discovered by Reichenbach. It is a volatile solid, and is obtained from creosote by the action of potash and acetic acid. It crystallises in a solution of sulphate of iron, forming orange-red crystals, which dissolve with a blue colour in sulphuric acid. The colour of oil of tar seems to be owing to this substance.

CEDROLE. [CEDAR-WOOD, OIL OF.]

CELERY, or APIUM GRAVEOLENS, is a wild umbelliferous plant by no means uncommon in the marshes of England, especially near the sea; in the isle of Thanet it is abundant. In its native station it has the character of being a poisonous plant, but transplanted to a garden it becomes an agreeable and wholesome vegetable. This is in conformity with the general properties of umbelliferous plants, in which two principles, the aromatic and the narcotic exist, and which are food or poison as the one or the other predominates. The narcotic is generated abundantly in moist places, and the aromatic principally in dry situations; and hence plants that are dangerous while growing in marshes, become wholesome when transferred to dry places. This appears to be one cause of the difference between the wild and the cultivated celery; another is, that the latter is blanched before it is brought to table, and thus the secretion of its deleterious principles is prevented.

Of garden celery there are many varieties; the best of which for salad is the Turkish, and for stewing, the Celeriac or the turnip-rooted sort. For soups, the "seeds" may be employed with as much advantage as the stems or leaves.

Celery is raised in beds, from seed sown from the end of March to the beginning of May, and requires a light, rich, well-drained soil. When the plants in the seed-bed are about two or three inches high, they are pricked out into another bed, where they remain till they are six or seven inches high; they are then transferred to trenches, in which they are placed in a row, and finally left. As they advance in size, they are gradually and carefully earthed up, till at last the whole length of the stem under ground is sometimes as much as four feet. The goodness of celery depends essentially upon its growing rapidly, being kept well drained from moisture, and having a solid stalk to its leaves. Celeriac is not earthed up, but is grown upon the surface of the ground, and kept free from weeds and preserved from the emission of strong lateral roots by frequent hoeing.

CELESTINES, ORDER OF, a monastic order, instituted about 1254 by Pietro da Morrone, afterwards Pope Celestine V., from whom they took the name of Celestines. Their first convent was at Murrone, in the Apennines of Abruzzo. It was a reform of the order of St. Bernard. Urban IV. approved its institution, and Gregory X. granted many privileges, with an exemption from payment of tithes, &c. It became a very rich order, both in Italy and France. In 1770, in consequence of an order from Louis XV., the Celestines of France held a capitulum, or general assembly, from the various houses they had in that country, to consider of several reforms in their discipline and economy, which were insisted upon by the king. These however they refused to adopt, and preferred the secularisation or suppression of their order, which was ultimately effected by Pius VI. in 1776-8. Their property was taken possession of by royal commissioners, a suitable pension being allowed to each monk. Some years after, Ferdinand IV. of Naples suppressed the Celestine convents in his kingdom.

CELLA. [TEMPLE.]

CELLULOSE ($C_{24}H_{20}O_{20}$). The different parts of all plants are built up of little cells or vessels somewhat after the manner of honeycomb, but more varied in shape. The walls of these chambers are universally composed of one substance, called cellulose. Its chemical composition is the same from whatever source obtained; it may, however, differ considerably in appearance and physical character. Thus in the hard shells and kernels of various fruits, such as the cocoa-nut, peach, or filbert, it is very dense; in hay and straw, tenacious and rigid; in hemp and flax, elastic; while in the pith of the rush or elder we have nearly pure cellulose in a spongy condition. It is also found as one of the proximate constituents of inferior animals, for example, in the tunics of ascidia and other molluscs.

Pure cellulose may be obtained from pith, old linen, finely carded cotton, or the better kinds of filtering-paper, by successively treating with boiling water, dilute alkali, chlorine, acetic acid, alcohol, and ether, and drying at a temperature of 212° Fahr. In this state it is a white solid; semi-transparent, tasteless, and odourless, and insoluble in cold water, alcohol, ether, or the fixed or essential oils. Boiling water very slowly converts it into dextrin. Concentrated sulphuric or phosphoric acid converts it first into dextrin, and, on dilution with water and ebullition, into glucose (grape-sugar).

When unsized paper is immersed for a few seconds in strong sulphuric acid diluted with half its volume of water, it is converted into an exceeedingly tough substance resembling parchment. This extraordinary change is entirely molecular, the chemical composition of the cellulose remaining unaltered.

Concentrated nitric acid converts cellulose into an exceedingly combustible substance [GUN-COTTON], in which the elements of nitrous acid (NO_4) replace part of the hydrogen in the cellulose. Strong caustic potash or soda causes it gradually to swell and finally disintegrate.

When moist cellulose and hydrate of potash, in equal proportions, are heated under slight pressure, hydrogen is evolved, wood-spirit distils, and formate, acetate, and carbonate of potash remain.

When cellulose is heated to about 400° Fahr. in contact with solid caustic potash, oxalic acid in large quantity is formed. Caustic soda does not produce the same effect.

Iodine does not colour cellulose until the latter has been acted upon with sulphuric acid, when a fine blue is produced. This reaction is of service in microscopical investigations, but prolonged action of the acid should be avoided.

Medulline, *fungine*, and *suberine* are but physical modifications of cellulose.

CELT, an instrument of stone or bronze, found in tumuli and other primeval earthworks. From being discovered in burial-places, and, among remains usually known as Celtic, these instruments are frequently supposed to have been called *celts* because of their employment by the Celtæ; but the name appears to have been given to them from an old Latin word, *celtes*, a chisel, in which sense the word is used in the Vulgate (Job xix. 24) and elsewhere.

The term celt has been somewhat indiscriminately applied to several kinds of cutting instruments: to small hatchets, axes, and even what appear to be military weapons, as well as to chisels; but the term is now restricted to chisels, or small instruments similar in character. Worsaae and some northern antiquaries would, indeed, confine the term to "instruments hollowed out to receive a wooden handle:" but in this he is not followed by English authorities. The most simple forms of stone or flint celts are extremely inartificial. Some have been merely chipped away, but most have been subsequently polished. They vary a good deal in size, but the common celt is about six inches long, and makes a certain approximation to the form of an incisor tooth; some

are more wedge-like in shape, the cutting end being wider, and of course thinner than towards the haft. That these instruments were used as chisels, the blunt end being fixed in a wooden handle, there can be little doubt; marks such as might be made by a chisel of this kind are still traceable on the canoes and wooden vessels which have been exhumed of primeval date, and instruments of a similar kind formed of jade are used at the present day by natives of the South Sea Islands in hollowing out and carving their canoes, &c. Stone celts are most commonly made of flint, but they have also been found of serpentine, jade, porphyry, sienite, siliceous schist, indurated clay-stone, &c. They are found very plentifully throughout Great Britain, Ireland, and the Channel Islands, and over the entire continent of Europe, and indeed wherever primeval antiquities have been dug up. Examples of them consequently abound in most European museums; the British Museum contains numerous specimens.

Bronze celts are scarcely less numerous than those of stone. They belong to a somewhat more advanced stage of social progress. In form they are more varied; and they must have been more varied in their mode of attachment, some being hollowed out to receive a handle, while others are shaped to fasten into a handle. The hollowed kind have usually an ear or ring attached, which it has been conjectured served to fasten the celt to its handle by means of a thong. Several moulds in which these bronze celts were cast have been found in various places. Numerous examples of bronze celts and moulds will be found in the British Museum.

Much interest has lately been excited by the discovery of "flint-objects," somewhat resembling in form and size the ordinary stone celts, and therefore by some called celts, in those undisturbed beds of gravel, sand, and clay known by the geological name of *drift*, and in what geologists term *bone-caves*. Objects of this kind appear to have been found in the drift at different periods without exciting particular attention,—several, for instance, are recorded ('Archæologia,' v. xiii.) to have been found in gravel 12 feet below the surface at Hoxne in Suffolk in 1797,—but no particular attention appears to have been given to the matter till M. Boucher de Perthes announced similar discoveries made by himself at Abbeville of very large quantities of flint implements, evidently shaped by the human hand, in undisturbed gravel beds at a considerable depth below the surface. M. de Perthes published his discoveries in his 'Antiquités Celtiques et Antédiluviennes,' 2 vols. 1847, but they at first attracted little notice. A second edition of his work appeared in 1857. Within the last few months discoveries of a similar kind have multiplied in a remarkable manner. Objects precisely similar were found in Brixham Cave, Devonshire, among the bones of extinct mammals; and shortly after, Dr. Falconer found them in various caves near Palermo, also in immediate conjunction with bones of large extinct mammals; whilst Mr. Prestwich and other geologists have been equally successful in their researches among the beds of drift in Suffolk, at Abbeville, Amiens, and elsewhere. In fact an immense quantity of these "flint-objects" have been discovered in various parts of England and the continent of Europe, and a great body of information accumulated. The objects differ somewhat in shape from the ordinary celts, are very much ruder, and always unpolished. They have been classed by Mr. J. Evans, one of the most zealous investigators of the drift, in a paper read before the Society of Antiquaries, as: "1. Flakes of flint apparently intended for knives or arrow-heads. 2. Pointed implements, usually truncated at the base, and varying in length from 4 to 9 inches,—possibly used as spear- or lance-heads, which in shape they resemble. 3. Oval or almond-shaped implements, from 2 to 9 inches in length, and with a cutting edge all round: they have generally one end more sharply curved than the other, and occasionally even pointed, and were possibly used as sling-stones, or as axes, cutting at either end, with a handle bound round the centre."

Mr. Evans, it will be seen, feels little doubt of their character; and most of the geologists who have taken part in the inquiry appear equally satisfied as to their being artificial products. The fact is however very far from being generally admitted. Mr. Thomas Wright, Mr. Cull, and other skilful antiquaries have published their reasons for doubting whether they are really works of human manufacture. The bearings of the question with reference to the date of man's existence on the earth are so important that the matter must be thoroughly sifted in every way before any statements can be received as conclusive. On the one hand, it will not be denied that, if found in any of the known places of human resort, or sepulture, their artificial character would have passed unquestioned. On the other, besides the difficulty arising from the extreme rudeness of the articles themselves, there are other difficulties suggested by the conditions in which they are found that cannot be overlooked. They are found amongst the bones of a great number of animals; yet although, as is presumed, objects of human workmanship, no human bones have been found with them; and this is the more remarkable because they occur in such quantities —hundreds together sometimes—and in so many places, that there must have been in the various localities a somewhat dense population to require so many cutting-tools, for whatever purposes they were used. It is, to say the least, a remarkable fact, that neither in the drift nor in the caves has any other trace of the existence of man been found except these rude "flint-objects," and that they should occur in such profusion. But we have no intention to draw any conclusions either way. Probably before long some facts will be brought to light that will go far to dissipate the difficulties which at present surround the subject.

CELTÆ, the name of an ancient race, which, according to the oldest historical records, occupied a great part of central and western Europe. The Celtæ appear to have been divided into two great families, the Gauls (Galli, in Greek Κελταὶ and Γαλάται), who occupied the country of that name from the remotest epoch on tradition, and who in their own language called themselves Celtæ; and the Cymri, who are by some considered to be the same as the Cimmerians (Κιμμέριοι), who appear to have migrated westwards at a later period from the countries bordering on the sea of Azof, and, advancing along the Danube, to have spread themselves across Germany to the Ocean. The latest inquiries into the Celtic language show a clear affinity between it and the languages called Indo-Germanic by modern philologists. The earlier Greek writers had very confused notions about the Celtæ. Herodotus (iv. 49) places the Celtæ at the sources of the Danube, and in the remotest west of Europe, beyond the Cynetes (an unknown people); but he does not mention them in his enumeration of the various nations who furnished the Carthaginians with mercenaries for their Sicilian wars. In the first Punic war we find Gaulish troops in the Carthaginian service. Eratosthenes named all the north-west of Europe Celtim; and we learn from the inscription found at Olbin, near Odessa, that Celts were settled in the Ukraine (Niebuhr 'Kleine Schriften') probably before the expiration of the second century before Christ. Other Greek writers confound the Celtæ with the Scythians, others with the Germans or Teutones (Fabri 'Thesaurus,' art. Galli et Galatæ, and references there). The messengers who carried to Athens the news of the burning of Rome by the Gauls (B.C. 382, according to Niebuhr), said that it had been effected by a great host of Hyperboreans, who had come over the icy mountains from the unknown regions of the north. (Plutarch's 'Camillus.') But long before this (589 B.C.) the Celtæ of Gaul had crossed the Alps, under Bellovesus, into northern Italy, and had become known to the Romans by the name of Galli, 'Gaels,' which seems to have been an aboriginal name of the oldest tribe of the Celtæ settled in western Europe. Livy and other ancient historians fix the immigration of Bellovesus in the reign of Tarquinius the elder; but Niebuhr is inclined to place it at a much later date. It is evident, however, that there were several immigrations of the Gauls into northern Italy, and at different times. The Galli, who occupied the plain north of the Po, drove away the Etruscans, but they never conquered either the Veneti, who were settled east of the Anthesis (Adige), or the Ligurians, who occupied the country south of the Po to the Mediterranean and the river Macra. The various Gaulish tribes that immigrated into Italy are believed to have belonged to the Ædui, Lingones, Ambarri, and Carnutes, who have left traces of their residence in northern Italy. The Insubres are said by some to have been a division of the Ædui. (Bossi, 'Storia d'Italia,' vol. ii. c. 9.) The Cenomani seem to have belonged to a later immigration; they occupied the country of the Orobii, the previous inhabitants of the hilly region about Como and Bergamo. Cato ('De Origin.') says that the Orobii were not Gauls. The Boii were likewise a later immigration of Gauls, who crossed the Po, and occupied the country south of that river. [BOII, in GEOG. DIV.] Lastly, the Senones spread south-east of the Boii, along the Adriatic coast, as far as Picenum. The Gauls never made a permanent settlement in Italy south of the Apennines.

Contemporary with the first recorded immigration under Bellovesus, another host of Gauls, under Segovesus, crossed the Rhine, and, advancing as far as the Hercynian forest, settled along the Danube, and in the country now called Bohemia, from which they were afterwards driven by the Marcomanni and other Teutonic or German tribes. Some of them penetrated into Illyricum, and settled among the Illyrians. The Scordisci, south of the Danube, appear to have been a tribe of Gauls. In very remote times the Celtæ of Gaul crossed the Pyrenees, and conquered part of Spain, where their descendants, becoming mixed with the aboriginal Iberians, formed the nation known to the Carthaginians and the Romans by the name of CELTIBERI. Some colonies of Celtæ penetrated to the western extremity of Spain, and we find them mentioned in the ancient geographers under the name of Celtici, both on the banks of the Anas (Guadiana) and on those of the Minius (Minho) in northern Lusitania.

The Gauls likewise are said to have crossed the sea into Britain, which they occupied. [BRITANNIA, GEOG. DIV.] But while the Gauls were thus spreading their colonies to the east, the west, and the south, they were themselves pressed upon from the north by the Cymri or Cimmerians, who appear to have been a branch originally of the same stock as the Gauls, and who had occupied western Germany. The Belgæ are believed by some, among whom is Niebuhr, to have been a mixed race of Cimmerians and Germans; Appian ('De Reb. Gall.') says that the Nervii, one of the chief Belgian tribes, were descendants of Cimbrians and Teutones. The epoch of the great Cimmerian immigration is unknown, and there is much confusion in the ancient historical records between the movements of the Cimmerians and those of the original Gauls. We know that the Belgæ occupied the northern part of Gaul and the southern part of Britain, and drove the Gauls farther inland. It appears also that tribes of Cymri occupied the north-west coast of Gaul, for the Veneti of lower Britanny were called Cymri or Cimbrians, as distinct from the Celtic Gauls around them. Diodorus

(v. 32) says, that Belgæ was the old name of the Cymri, and he quotes Posidonius, who calls them Galatæ or Cimbrians, while he calls the Gauls by the name of Celtæ. Ammianus Marcellinus (xv. 9) records as a tradition of the Druids that a portion of the Celtæ came into Gaul from beyond the Rhine, and passed afterwards into south Britain, from whence they drove the original Gauls farther inland. The distinction between Gauls and Cymri has been perpetuated, at least in name, down to our days, in the Gaels of Scotland and the Welsh, the language of the latter being called Cymri, as well as that of the Armoricans, or inhabitants of Brittany, while that of the Gaels of Scotland is called the Gaelic. The Cimbri of Marius appear to have been a tribe of Cymri who had settled in northern Germany, or, according to some ancient writers, among the Scythians, and from them came the Celto-Scythians, who joined the Cimbri in their westward irruption. (Plutarch, 'Marius.') There is sufficient similarity between the manners and institutions of Gauls and Belgians to make them appear cognate races: both had a powerful Druidical hierarchy; both were divided into optimates, or freemen, and the common people, who appear to have been little better than serfs; both were hasty, violent, and impatient (Niebuhr, 'History of Rome,' vol. ii., where he treats of the Gauls and their immigrations); both appear to have been distinct from the Teutonic or German race, as well as from the Iberian and Ligurian.

About 280 B.C. a vast multitude of Celtæ or Gauls invaded Macedonia and Greece. According to Justin they started from Pannonia, where their ancestors had settled long before. It is probable that they were joined by other tribes, either of Celtic Gaul, or of Cymri, coming from western Germany, or of both. Justin mentions among them the Tectosages, from the neighbourhood of Tolosa, but his account is very confused and contradictory. (Compare b xxiv. 8, with b. xxii. 3.) The invaders were divided into two great bodies: one under a chief, whom Justin calls Belgius, and Pausanias Bolgos, invaded Macedonia, spreading terror and desolation everywhere before them. Ptolemæus Ceraunus, king or usurper of Macedonia, having attempted to oppose them, was defeated and killed. They made an immense booty, plundered the temples without scruple, and then retraced their course homewards. The other host of Gauls, under Brennus, entered Macedonia the following year, 279 B.C., and defeated Sosthenes, who, after the death of Ceraunus, had assumed the government of that country. Brennus then advanced through Thessalia, and southward as far as Delphi, with the intention of plundering that rich sanctuary. The Gauls were however put to flight, partly by the resistance of the people of Delphi, and partly, it is said, by an earthquake, which took place during the attack, and which was followed by a fearful storm. These phenomena were attributed to the wrath of the offended God. The attack on Delphi appears to have taken place in 278 B.C. (Clinton, 'Fasti Hellenici.') Brennus, through mortification, killed himself. The Gauls lost vast numbers in the repulse, and still more in their retreat northwards, being harassed by the hostile populations. Another incursion into Macedonia was made soon after by another host of Gauls, who had not been in the Delphic expedition, but had remained on the frontiers of Pannonia. (Justin, xxv. 1, 2.) After defeating the Getæ and Triballi, they were met by Antigonus Gonatas, and totally routed. The remnants of these expeditions withdrew into Thrace, where parties of Gauls had been in the habit of making incursions, to the great annoyance of the Byzantines. [BYZANTIUM, GEOG. DIV.] Being however invited by Nicomedes I., king of Bithynia, who was then at war with his brother Zybœthes [BITHYNIA, GEOG. DIV.] and being provided by the same with boats, they crossed over into Asia, and effectually supported his claims to the throne.

They then settled in the interior of Asia Minor, to the south-east of Bithynia, and occupied a great tract of country, which from them was called Galatia and Gallogræcia. It was bounded north by Paphlagonia, west by Phrygia and Bithynia, south by Cappadocia, and east by Cappadocia and Pontus. They made frequent incursions into the neighbouring countries, but were checked by Antiochus I., who defeated them, and was in consequence called Soter or Saviour. Three principal tribes of Gauls are mentioned as having settled in the country; the Tectosages, whose principal town was Ancyra; the Tolistobogi, who lived near the sources of the Sangarius, and whose principal town was Pessinus, famous for its temple of Cybele; and the Trocmi, who lived more to the east, near the banks of the Halys. (Leake's 'Asia Minor.') The Galatæ are frequently mentioned in subsequent history as mercenaries in the armies of the kings of Bithynia and of Pontus, and also in those of the later kings of Macedonia and of Syria. They seem to have had their own kings or chiefs, some of whom are mentioned in history; among others, one Cavarus, who acted as mediator between Prusias I. king of Bithynia, and Attalus king of Pergamus. Sestini has given an account of several medals of Cavarus and other kings of the Gallogræci. During the war of the Romans against Antiochus III., the Consul C. Manlius invaded Gallogræcia 189 B.C., for which he obtained the honour of a triumph, 186 B.C. (Livy, 38 and 39.) Mithridates the Great, in his wars against Rome, occupied Galatia, and we find the Galatians forming an essential part of his troops. One of their chiefs, however, Deiotarus by name, forsook the part of Mithridates in favour of Rome, in consequence of which he was acknowledged as king by the Roman Senate. It was for the son of this Deiotarus, called also Deiotarus II., that Cicero pleaded before Cæsar. After this Galatia became a province of the Roman empire. Several names of places in Galatia attested the relationship of the new settlers to their western brethren, such as Ecobriga, Tolistochora, &c.

The power of the Gauls in Europe was evidently on the decline long before Cæsar's conquest of their country. They were pressed on one side by the Belgæ and the Germans, and on the other by the Iberians, who had settled in Aquitania. The Gauls of Italy had been all subjugated by Rome. The Romans had also occupied the Province of Narbo, which originally belonged to the Celtic Gauls. For the names and localities of Celtic Gaul in Cæsar's time, see CÆSAR, in BIOG. DIV.; and for those of the Celtæ of Britain, see BRITANNIA, in GEOG. DIV.

The distinguishing features, both physical and moral, of the Celtic race, whether Gauls or Cymri, are described by most ancient writers, especially Cæsar, Livy, Diodorus, Appian and Justin; but their accounts are not free from contradictions. They were men of large size, of fair complexion, reddish hair, and fierce aspect; they wore their hair long, with moustaches, but most of them showed the chin. They could bear cold and rain, but not heat or thirst. They were vain and boastful, clamorous and impatient of control, and quarrelsome among themselves. Their first onset was formidable, but if once repulsed they easily gave way and dispersed. Their swords were long and unwieldy; those of the Celtic Gauls appear to have been made of copper, but they bent after the first blow, which gave a great advantage to the Romans over them: some of them also used lances with iron heads, and the bow was not unknown to them. The Gauls fought generally naked down to the loins. Their shields were large and oblong; but they appear to have been slight and ill contrived for protection. Livy (xx. 46) well describes the contrast between the appearance of the Gauls in Hannibal's army and that of the Spanish mercenaries. Their dress was a striped or coloured jerkin, hose and trousers fastened with a girdle in many cases of gold and silver, with an over-coat, also coloured, of varied materials for summer or winter. Their government was aristocratic; the optimates or nobles formed the senate or supreme council: the common people seem to have had no political rights, and to have been in a state of depression. We find that one more powerful tribe, such as the Bituriges and Ædui, exercised, at least for a time, a sort of political supremacy over the neighbouring tribes. Their kings or chiefs appear to have been elective, and to have held their office only for a year or two, unless re-elected. The Druids formed a powerful hierarchy; they were interpreters of the law, and judges in civil and criminal matters. The Druids seem to have been an hereditary caste, though not exclusive, being recruited from the young men of noble families who resorted to their academies to study. Cæsar ('De Bello Gall.' vi. 13) gives a good sketch of the institutions of the Gauls in his time, which he contrasts with those of the Germans. He says that Druidism was supposed to have come from Britain into Gaul. The religion of the Celtæ was originally a sort of theism; they had no idols or images, against which they showed a particular aversion in their invasion of other countries; they worshipped the Supreme Being in sacred groves. The oak and the misletoe were sacred. They afterwards adopted some of the gods of the Germans and other nations. They had also bards, who were not only poets but soothsayers, and their songs were transmitted by tradition. The Druids offered human sacrifices, and they drew omens from certain appearances in the limbs and blood of the victims, and also from the flight of birds. The latter was resorted to in case of emigration to direct their course. Diodorus (v.) says that the Druids had instruments by which they could bring distant objects either on the earth or in the heavens, nearer to them. He tells some wonderful stories of the Celtæ or Gauls, which show how little that people were known at Rome even in his time. He says that "those who inhabit farthest north towards Scythia are the most ferocious, and they are said to devour human flesh, like the Britanni who inhabit Irin (Ireland)." The Celtæ of Gaul had attained a considerable degree of civilisation and luxury when Cæsar entered their country. They seem to have been acquainted with the Greek language by means of the colony of Massilia (Marseille), and the Greek alphabet was in use among them. We do not know of any original Celtic alphabet, nor of any works in their language. Indeed we have no knowledge left of the language of Celtic Gaul, unless we suppose it to have been similar to the Gaelic of Scotland. The Breton language, like the Welsh, is a dialect of the Cymri language belonging to that great division of the Celtæ. It was long disputed whether the Basque language was a dialect of the old Celtic, but it is now generally conceded that the two are not related. The remains of the old Celtic language must therefore be sought in the Gaelic, and in the Erse or Irish, which is said to resemble the Gaelic; and in the Welsh and its cognate dialect, the Breton. These seem to be the only probable offspring of the Celtic Gaul and the Cymri, Cimmerian, or Cimbrian. For a large collection of authorities respecting the Celtæ and their various branches, see Forbiger's 'Handbuch der Alten Geographie,' vol. iii. 1848.

CELTIBE'RI, a people of ancient Spain, supposed to have been descended from Celtæ, who in remote times immigrated from Gaul, and afterwards became mixed with the native Iberians, so as to resemble in their habits more the latter than the former people. The Celtiberi extended from the right or south-west bank of the Iberus (Ebro) towards the interior of Spain. They occupied the highlands

about the sources of the Duero and the Tagus, and both sides of the great central ridge which divides the waters which flow east towards the Mediterranean from those which flow west into the Duero and the Tagus. The Celtiberi are spoken of by the Greek and Roman writers sometimes as a single people, sometimes as a confederation of various nations. In the latter sense they extended over a great part of central Spain, including the Arevaci, Peleadones, Lusones, Belli, and Tisthi. Appian places even the Vaccæi among the Celtiberi, but according to Niebuhr they were pure Iberians. Numantia, in the country of the Arevaci, is said by Florus to have been defended by 4000 Celtiberi. The principal towns of the Celtiberi were Segobriga, not far from Numantia, and different from the Segobriga, now Segorbe, near Valentia, Turiaso, now Tarazona Bilbilis, the birth-place of Martial, now Calatayud; Argobriga, &c. The Celtiberi were a brave people, superior, in firmness, to the Lusitani, who were chiefly pure Celts, and they proved formidable both to the Carthaginians and the Romans. After having submitted to Rome in the second Punic war, they repeatedly resumed the contest, fought against Fulvius Flaccus, were subjugated by T. Sempronius Gracchus 179 B.C., revolted a few years after again under the prætorship of Appius Claudius, and were again defeated. They fought afterwards against C. Marcellus and Licinius Lucullus. After the destruction of Numantia by Scipio Æmilianus they were finally subdued. Their country became part of the Roman Provincia Tarraconensis. (Appian. 'De Rebus Hispan.'; Livy, &c.)

CELTIC ARCHITECTURE. Under this term are classed the structures, or collections of stones, which are usually considered to be the work of the natives of our island anterior to the arrival of the Romans. But very few, if any, of these structures have any claim to be regarded as architectural works. The beginnings of architecture are, however, undoubtedly perceptible in the series of stones, each consisting of two uprights and an impost, which form so striking a feature in the circles of Stonehenge: but they are only the beginnings. The upright pillars have evidently undergone shaping; and the mode in which the imposts were secured by mortises and tenons, shows a regular principle of construction. Something, also, of architectural arrangement is exhibited in that very remarkable group of stones, and in the far more extensive, but ruder series, at Avebury in Wiltshire and Carnac in Brittany. But the ordinary stone circles and cromlechs of this and other countries are mere rude collections of unhewn stones.

The objects chiefly understood, when Celtic remains are spoken of, are the stone circles mentioned above, cromlechs, kistvaens, and upright stones,—all of which are of the kind once generally, and still very frequently, termed Druidical; the circles being regarded as Druidic temples, the cromlechs as Druidic altars. Stonehenge, the most perfect and the most finished of the stone-circles now remaining, and Avebury, the most extensive relic of the kind left in this country, will be found fully described (and the conjectures as to their purpose examined) in the GEOGRAPHICAL DIVISION of the ENGLISH CYCLOPÆDIA; Stonehenge under WILTSHIRE, vol. iv., cols. 1139–41; AVEBURY under that title, vol. i., cols. 743–6; and the great circle at Carnac under MORBIHAN, vol. iii., col. 863. CROMLECHS will be treated of under a separate heading in the present Division; and the small circles of stones which formed the boundaries of barrows or tumuli, and kistvaens, which are the stone chests or frames which were placed within the barrows, will be spoken of under TUMULI; and under those heads the several purposes they were intended to fulfil, and the state of civilisation of which they are the evidence, will be most conveniently examined. Here it will be enough to add, that whilst circles, upright stones, and cromlechs are found very widely distributed throughout Europe (and objects bearing a marked resemblance, if not a very near affinity to them, are found in other parts of the world also), no remains of any houses or buildings, properly so called, of the Celtic period, have been discovered. The "Pen-pits" described by Sir R. Colt Hoare, and by him called British Houses, can at best have only been the foundations of houses of which the superstructures (which, if we may trust Diodorus Siculus, were ordinarily among the Britons only built of reeds or wood) have perished.

CEMENT. At the present day the term cement is specifically applied to those building materials used for the purpose of connecting small stones, or bricks, which set very rapidly; and in this respect cement differs from lime mortar, for the rate of setting of the latter is essentially slow and progressive. Cements themselves are subdivided into the *calcareous*, and the *gypseous*, and into the *natural* and *artificial*; perhaps also a mixed class of iron, glass, oil, and bituminous cements might be added to these, but their use is very limited.

The natural calcareous cements are those obtained by the calcination of the argillaceous limestones, in which the silicate of alumina is present in the proportions of from 30 to 60 per cent. of the whole mass, though in the best materials of this description the proportion of the silicate rarely attains even 50 per cent. It appears that after a stone of this description has been deprived of its carbonic acid gas, and its water of crystallisation, by the process of calcination, it is susceptible of forming, by the addition of water, a new hydrated double silicate of lime and alumina, with very great rapidity; and that the combination so formed is of a very permanent character, and of great hardness and tenacity. The degree of heat required for this calcination is moderate, *in the case of the natural cements*, and the stone loses in the kiln about one-third of its natural weight. It is then ground, and packed in as air-tight a manner as possible in casks; for the powder thus obtained has a great affinity for moisture, and it absorbs readily that which may be in suspension in the atmosphere. The cements made, and treated, in this manner are usually known in commerce as the Roman cements, and those sold in England are obtained by the calcination of the nodules of septaria dispersed in the liassic, the Oxford, or the tertiary clays. Similar nodules are found in the clays of the oolitic series near Boulogne, at Pouilly, Vassy, &c., in France; and in the United States and Canada. As the composition of the nodules used in the manufacture of the English natural cements represents the normal type of this class of materials, it is added:—

		Sheppy.	Harwich.	Yorkshire.
Carbonate of Lime	per cent.	55	49	62
Silicate of alumina	,,	38	47	34
Oxide of iron and other substances	,,	7	3	4

The so-called Medina cement approaches very closely in its composition to the Yorkshire, or Atkinson's cement.

It is usually considered that the lighter the specific gravity of a natural cement may be, the better will be its useful properties; and that the finer the powder into which it is ground, the more regular will be its action. Upon the first addition of water, a certain amount of heat will be evolved from the portion which enters into chemical combination with the cement, and the operation of setting should not be allowed to commence until the whole of this heat is given off. The rate of setting will depend very much upon the quantity, and the quality, of the water used, and upon the proportions of sand mixed with the cement; when pure cement, treated in the best manner, is used, the setting will, in fact, take place within about six minutes; whereas if two proportions of sand be used to one of cement, and much water be introduced, the time of setting may extend to as much as one hour twenty minutes; and if the mortar so made be immersed in sea water, the time of setting may even reach twenty-four hours. It is considered that the average resistance of pure natural cements to crushing weights, is equal to about 746 lbs. per superficial inch, to an effort of traction, their powers of resistance are only equal to 54 lbs. per superficial inch.

Artificial cements are made either by mixing with the feebly hydraulic limes natural substances, such as pozzuolano, or trass, which are able to impart to them the power of setting under water; or by the addition of broken tiles, or underburnt clay, to those limes. Of late years, however, both these systems of making artificial cements have been abandoned in England, and the use of what is called (rather absurdly) the Portland cements has been substituted for them. These Portland cements are obtained by burning together, under the influence of intense heat, certain proportions of a soft and pure carbonate of lime (such as the middle chalk around London) and the fine alluvial mud of our English rivers; the proportions of clay and carbonate of lime being about, or rather less than, those of the Yorkshire cement stones.

The principal difference between the natural and the artificial calcareous cements, consists, it is to be observed, principally in the degree of heat to which they are exposed; and it would appear that the combinations effected under these circumstances have a very marked influence upon the ultimate powers of resistance the cements attain. The Portland cements, indeed, do not set so rapidly as do the Roman cements, but when the setting has once commenced, the strength of the resulting material continues to increase indefinitely; whereas the Roman cements soon attain a degree of strength which they do not subsequently exceed—even if they retain it. The resistance of Portland cement, of the best description, to efforts of compression, is estimated to be equal to 2074 lbs per superficial inch; and to efforts of traction to 146 lbs. per superficial inch. The time of setting is at least from three to four times longer than that of the natural cements.

In works of internal decoration the gypseous cements are largely used; and the rapidity with which they pass through the chemical changes effected during their application, gives them a decided superiority over the ordinary plasters. The materials of this description most generally used are the Keene's, or the Parian cements; the former of which is obtained by recalcining a dehydrised sulphate of lime, which has been subsequently saturated with a solution of alum and water; the latter is obtained by recalcining, in the same way, a plaster saturated with a solution of borax. Of the two materials, the Parian cement is by far the better.

The oil cements, or the mastics, were formerly much used in London, but they have so signally failed that it may suffice to say, that they are composed of a mixture of lime, powdered tiles, litharge, and oil; they produce a good face for ornamental work in sheltered positions, but they do not resist the London atmosphere, nor have they any valuable powers of resistance as cementitious materials.

Having thus described the most important among the cements used by civil engineers and builders, we proceed to notice briefly several compositions, intended chiefly to cause the adhesion of surfaces in many departments of the manufacturing arts. Several are described in later articles. [GLUE; LUTES; MASTICH; SOLDER.] Referring to those articles for information on the special subjects to which they relate, we will confine our attention to adhesive compositions of a mis-

cellaneous kind—such, for example, as are intended for temporary use, for mending articles which have been broken, or for replacing damaged parts.

Temporary cements are such as are used for holding articles firmly during the operations of the workmen, and which are easily removed when there is no further occasion for them. Thus, in fixing glass plates to blocks to be ground for optical purposes, the following is recommended as a useful cement: melt together four ounces of resin, a quarter of an ounce of bees'-wax, and add four ounces of whitening, previously made red hot, while yet warm. This cement will also answer the purpose of joining metallic plates to be turned in a lathe.

Chasers of gold and silver articles support and hold their work by a cement formed of pitch, resin, and a very small quantity of tallow melted together, and thickened by stirring in brick-dust; this cement may also be used for fixing small steel articles on the blocks intended to hold them for polishing. In winter more tallow is necessary than in summer. Shell-lac is also usefully employed for holding metals, glass, or precious stones, while cutting, turning, or grinding them; the metal or other substance should be warmed to melt the cement.

Permanent cements are prepared with various ingredients. Thus, supposing ornaments of Derbyshire spar or other similar substances to be injured by being chipped or broken, the parts may be restored by using a cement composed of seven or eight parts of resin and one of bees'-wax, with a little plaster of Paris, melted together. The pieces of spar must be heated until they are hot enough to melt the cement, and this being interposed, the parts are to be pressed together; when the cement is used to fill up the place of any small pieces that may have been lost, the quantity of plaster of Paris must be increased. Sulphur also, placed between the heated surfaces of broken stones, makes a good cement; and when little holes are to be filled up, some of the hardened stone should be mixed with the melted sulphur.

Jewellers, in setting precious stones which have been accidentally broken, cement the pieces together by applying mastich between the fragments, which are sufficiently heated to melt this resin; they are then pressed together to force out the excess of mastich. A cement for glass and porcelain is made from a mixture of lime and white of egg; and the same purpose is also answered by dissolving gum arabic in a little water, adding proof spirit and gum ammoniac.

Another cement for the same purpose is prepared by mixing three parts of isinglass soaked in warm water for half an hour; pour off the water and add one part of gum ammoniac, previously dissolved in proof spirit of wine; the mixture is to be heated until a drop of the composition becomes instantly stiff by cooling. When used to join broken porcelain or glass, the pieces should be first warmed; the fluid cement should be laid on with a brush, and the pieces pressed together; or, if necessary, tied to prevent their separation.

Japanese cement is said to be prepared by mixing rice-flour intimately with cold water, and then boiling the mixture; it is white, and dries nearly transparent. It is therefore very useful in the manufacture of curious paper articles, which require layers of paper to be cemented together. When made with a smaller quantity of water, models, busts, &c., may be formed of it.

A cement used for engineering works is prepared as follows: take two ounces of sal ammoniac, one ounce of flowers of sulphur, and sixteen ounces of cast-iron filings or borings. Mix them well by rubbing in a mortar, and keep the mixture dry: when it is wanted, take one part of this powder and twenty parts of clean iron borings or filings, and mix them thoroughly by grinding in a mortar; add enough water to give a proper consistence, and apply it to the joints. In this case chemical action goes on, sulphuret of iron being slowly formed, and a great degree of hardness is acquired.

In joining the flanches of iron cylinders, a mixture of litharge, red and white lead, boiled in linseed oil, is made use of. It may be applied spread on flannel or linen, placed between the joints before they are screwed together. The proportions of the ingredient are not important, provided too much oil be not used, so as to make the composition too thin. This cement answers for the joints of stone cisterns intended to hold water.

Coppersmiths lay over the rivets and edges of the sheets of copper in large boilers a mixture of quicklime and ox's blood. It must be applied fresh made, as it soon hardens; this cement is both cheap and effectual.

According to Mr. Singer, a good cement for electrical apparatus is prepared by melting together about five pounds of resin, one pound of bee's-wax, one of red ochre, and about two ounces of plaster of Paris.

What is called 'mouth glue,' and the adhesive composition at the back of postage-stamps and luggage-labels, are useful examples of a very speedy mode of cementing by moistening the surfaces on which the adhesive composition has been spread.

CEMETERY. [INTERMENT.]

CENSER, a vessel used for burning and wafting incense, from the French *encenser*, to perfume. It was called by the Greeks Thymiatérion (*θυμιατήριον*), and by the Romans Thuribulum, and was often made of gold or silver, and enriched with gems. The censers of the ancient Hebrews were a sort of chafing-dishes, or perfuming-pans, with or without handles, which the high-priest placed on the altar of incense, or carried into the sanctuary. St. John in the Revelations (v. 8), speaking of the censers held by the four-and-twenty elders, calls them dishes only, or golden cups full of incense; such, probably as occur upon the reverses of the coins of Simon Maccabæus. Josephus speaks of a very large number of golden censers, made by Solomon for the Temple at Jerusalem. A censer with smoke issuing from it occurs upon some of the Hebrew silver coins of modern time. Censers are still used in the Roman Catholic worship, and are usually carried by acolytes. Censers or thuribles of mediæval date are often of very rich workmanship. They often occur of the 12th century and later in the form of a church. According to Theophilus the monk, thuribles were directed to be made in the form of a temple, but the temple form never appears to have been general.

CENSOR, the name of one of the superior magistrates in ancient Rome. There were two officers of this name, *censores*. They were first created A.U.C. 311 (B.C. 443), when the consuls were too much occupied with the concerns of war to allow of their making the census themselves. (Liv. iv. 8.) At first they were exclusively of the patrician order; the first plebeian who was elected was C. Marcius Rutilus, A.U.C. 403 (B.C. 351.) (Liv. vii. 22.) In 622 (B.C. 132) both were plebeians, L. Pompeius and L. Metellus. (Liv. 'Epit.' lix.) Originally, according to Niebuhr, vol. ii. 394, the censors were chosen by the patrician body, the curies (*curiæ*), and their election was confirmed by the centuries; in later times they were chosen by the centuries, and their election was confirmed by the curies; the centuries also passed the law by which the censors formally received their powers; thus the centuries voted twice over.

At first the censorship lasted for five years, but a law was afterwards passed abridging its duration to a year and a half. (Liv. iv. 24.) The office underwent many changes in the time of the emperors. Julius Cæsar acted for several years as Præfectus Morum, and subsequently was made censor for life. Augustus performed the functions of the office, but refused the title. Under Tiberius the censorship was abolished (Tacit. 'Ann.' ii. 33), and no attempt at its restoration was successful.

When one of the censors died, it was not the custom to choose another in his place; it is true this was once done, but in the same lustre Rome was taken. Superstitious reasons prevented a repetition of the experiment. Accordingly, on the death of one, the remaining colleague resigned, and two fresh censors were chosen. (Liv. v. 31; vi. 27.) Their duties originally were the administration of the public property and revenues, registering the citizens according to their different orders, and keeping the land-tax rolls. In itself the office was insignificant, but in the hands of influential persons it was likely to become powerful. (Liv. iv. 8.) The rank of the citizens and the valuation of taxable property were at the disposal of the censors. The power thus entrusted to them naturally grew with exercise, till in later times it became despotic. No order in the state was exempt from their control. They could exclude a senator from the senate-house, deprive an eques of his horse and rank, or remove a plebeian from his tribe. To inspect the manners and guard the morals of the people was a somewhat indefinite commission; and, though parental indulgence and petty family squabbles seem unsuitable subjects for the interference of the state, it is often difficult to determine whether the actions of the censors were in reality over-rigorous, or only conscientiously strict. (Nieb. vol. ii. p 397.) If a man let his field run wild, the censors considered him unworthy of his order, and forthwith removed him from his tribe. But notwithstanding the immense power which they thus exerted over the rights and privileges of a Roman citizen, no instance is found of their having deprived him of his franchise. When it is said (Liv. viii. 17) that they added new tribes to the old ones, it is not implied that in these cases they acted on their own independent authority, but only that *they*, and *no other* magistrate, proposed to the people the law which effected the addition. (Nieb. vol. ii. p. 399.) They could no more give the freedom of the city to foreigners, than they could take it from citizens.

They could go farther than the rank and character of the citizen in their punishments. Whenever they thought a man deserved it, they could brand him with public disgrace—a stigma corresponding to *ἀτιμία* at Athens. But of this censorian atimy or ignominy at Rome, there were two kinds. It was inflicted by the censors, sometimes in their own name and authority, and sometimes in the name of a court of law, whose judgment they only executed. The merely *censorian* brand did not disqualify a man for the functions of a citizen, or even for preferment to posts of honour; an appeal always lay, and was sometimes actually made from their sentence to the people; the censors themselves even went so far as to stigmatise one another. (Liv. xxix. 37.) Cicero mentions ('Pro Cluent.' 42, 119) an instance of one man, C. Geta, who had been ejected from the senate by L. Metellus and Cn. Domitius, and was afterwards created censor, so that he who had himself fallen under the censorian rebuke, actually presided over the morals of the Roman people, and of those very men who had reprehended him. This was never the case when the censors inflicted the sentence for a judicial court. That sentence, once passed, they were unable to revoke. The administration of the public revenues was a part of the business of the censors, and we find them not only establishing tolls and excise duties in subject towns, but actually fixing the price at which salt should be sold in Rome itself. They let to farm the customs and the contracts for public works. They superintended the roads, and took care of the public books and documents. Cases of

marriage and betrothing came under their inspection. (Varro, 'de L. L.' vi. 71, ed. Müller.) Their acts were registered in public documents; and the purity which was required in those who filled the office is indicated by the circumstance, that those documents were preserved in the temple of the Nymphs. (Cic. 'pro Mil.' 27.) The writing was probably performed by public slaves in the service of the censors. (Liv. xliii. 16; Nieb. vol. ii. p. 404.)

The censors might be tried when they acted improperly (Liv. xxiv. 43), and even be led to prison (ix. 34), or thrown from the Tarpeian rock. (Liv. 'Epit.' lix.)

There were also censors in many of the municipia, and in the provinces. (Cic. in 'Verr.' ii. 53.)

In modern times an officer has been appointed in different countries under the title of *censor*, whose business has been to examine all books previous to their publication, and to see that they contain nothing which the government considers immoral or heretical. In England, before the revolution, there was an officer of this kind. [CENSORSHIP OF THE PRESS.]

CENSORSHIP OF THE PRESS, a regulation which has prevailed in most countries of Europe, and still prevails in many, according to which printed books, pamphlets, and newspapers, are examined by persons appointed for the purpose, who are empowered to prevent publication if they see sufficient reason.

There are different modes of censorship; the universal previous censorship, by which all manuscripts must be examined and approved of before they are sent to press; the indirect censorship, which examines works after they have been printed, and, if it finds anything objectionable, stops their sale and confiscates the edition, and marks out the author or editor for prosecution; the optional censorship, which allows an author to tender his manuscript for examination, in order to be discharged from all responsibility afterwards; and lastly, by a distinction which has been very commonly made between newspapers or pamphlets and works of a greater bulk, the censorship of the journals, which exists even in countries where larger works are free from this superintendence. All these forms of censorship imply an establishment of censors, examiners, inspectors, or licensers, as they have been variously called, appointed for the purpose, a provision quite distinct from the laws which define the various offences which a man may be guilty of by publication. These are repressive or penal laws, whilst the censorship, and especially the previous censorship, is essentially a preventive regulation.

The censorship may be said to be coeval with printing. In more ancient times, those writings which were obnoxious to the prevailing political or religious systems, if they fell under the eyes of men in authority, were condemned to be destroyed. Thus, all the copies of the works of Protagoras which could be found in Athens were publicly burnt by sentence of the Areopagus, because the author expressed doubts concerning the existence of the gods. Personal defamation and satire were also forbidden. Nævius at Rome was banished, some say put in prison, for having, in his plays, cast reflections on several patricians. Augustus ordered the satirical works of Labienus to be burnt, and Ovid's alleged or probable cause of exile was his amatory poetry. The senate under Tiberius condemned a work to be burnt, in which Cassius was styled the last of the Romans. Diocletian ordered the sacred books of the Christians to be burnt, and afterwards Constantine condemned the works of Arius to the flames. But even under the despotism of the Roman emperors, proof of the truth of the allegations secured an exemption from punishment. (Tacitus, 'Annal.' i. 72.) All these, however, were penal enactments, independent of any censorship. The councils of the Church condemned books which they judged to be heretical, and warned the faithful against reading them. Afterwards the popes began to condemn certain works, and prohibit the reading of them. In the time of Huss and Wycliffe, Pope Martin V. excommunicated those who read prohibited books. The introduction of printing having awakened the fears of the ecclesiastical authorities, several bishops ordered books to be examined by censors. One of the earliest instances of this is that quoted by Johann Beckmann, in his 'Book of Inventions,' of Berchthold, Archbishop of Mainz, who in the year 1486 issued a mandate, in which, after censuring the practice of translating the sacred writings from the Latin into the vulgar German, a language, he says, too rude and too poor to express the exact meaning of the inspired text, he adverts to the translations of the books of the canon and civil law, works, as the archbishop says, so difficult as to require the whole life of man to be understood, a difficulty which is now increased by the incompetence of the translator, which renders obscurity still more obscure. His grace therefore, setting a full value on the art of printing, "which had its cradle in this illustrious city of Mainz," and wishing to preserve its honour by preventing it being abused, forbids all persons subject to his authority, clerical and lay, of whatever rank, order, and profession, to print the translation of any work from the Greek, Latin, or any other language, into German, concerning any art, science, or information whatever, publicly or privately, unless such translation be read and approved of before being printed, and, when printed, before being published, and furnished with the written testimony of one of the doctors and professors of the University of Mainz, named by the archbishop, one for theology, one for law, one for medicine, and one for the arts. All who violated this order were to lose the book, pay a fine of one hundred gold florins to the Electoral

Chamber, and be excommunicated. There was however no general system of censorship in the 15th century, which was an age of freedom for printing; and it is a curious fact that the learned scholar Merula, in a letter to his friend Poliziano, dated 1480, expresses a wish that a previous censorship should be established over all books, such as Plato recommends for his republic, "for," says Merula, "we are now quite overcome by a quantity of bad or insignificant books."

In 1501, Pope Alexander VI. (Borgia) issued a bull, in which he strictly forbids all printers, their servants, and all who exercise the art of printing in any manner in the above provinces, to print hereafter any books, treatises, or writings, without previously applying to the respective archbishop, or his vicar and officials, or whomsoever they may appoint for the purpose, and obtaining their licence free of all expense, under pain of excommunication, besides a pecuniary fine at the discretion of the respective archbishops, bishops, or vicars-general. The bull provides for the books already printed and published, which are to be examined by the same authorities, and those containing any thing to the prejudice of the Catholic faith are to be burnt.

At last, in 1515, the Council of the Lateran decreed that in future no books should be printed in any town or diocese unless they were previously inspected and carefully examined, if at Rome by the vicar and the master of the sacred palace, and in the other dioceses by the bishop or those by him appointed, and by the inquisitor of that diocese or those by him appointed, and countersigned by their own hands gratis and without delay. Any book not so examined and countersigned was to be burnt, and the author or editor excommunicated.

Here, then, was the origin of the principle of a general censorship of the press, which has been ever since maintained by the Church of Rome in all countries where it had power to enforce it. The bishops were the censors in their respective dioceses; but the tribunal of the Inquisition, wherever the Inquisition was established, were the censors; they examined the MS. of every work previous to its being printed, and granted or refused an "Imprimatur," or licence at their pleasure. In countries where the inquisition was not established, such as France, England, and Germany, the bishops acted as censors and licencers of books, which they examined or caused to be examined previous to printing, as to all matters concerning religion or morality.

The censorship continued for a long time to belong to the ecclesiastical power; and even afterwards, when the civil power in various countries began to appoint royal censors to examine all kinds of works, the episcopal approbation was still required for all books which treated of religion or church discipline.

The Reformation greatly modified the censorship and reduced its powers, without however abolishing it: the power passed into other hands. In England the practice seems to have been to appoint licensers for the various branches of learning; but the bishops monopolised the principal part of the licensing power, as we find at the beginning of the reign of Charles I., in a petition of the printers and booksellers to the House of Commons complaints against Bishop Laud that the licensing of books being wholly confined to him and his chaplains, he allowed books which favoured Popery to be published, but refused licensing those which were written against it. The system of previous licensing, however, did not always secure an author from subsequent responsibility. Thus Prynne's 'Histriomastix' was condemned, in 1633, to be burnt by the hangman, for being a satire on the royal family and government, and the author to have his ears cut off, and to be imprisoned and heavily fined, although the book had actually been licensed, but it was alleged on the trial that the licenser had not read the whole of the work.

A decree of the Star Chamber concerning printing and licensing, dated 11th of July, 1637, was issued, in order to establish a general system on the subject. The preamble refers to former decrees and ordinances for the better government and regulating of printers and printing, and particularly to an order of the 23rd of June, in the 28th year of Elizabeth. It then goes on to provide that all books concerning the common laws of the realm shall have the special approbation of the Lords Chief Justices and Lord Chief Baron for the time being, or one or more of them, or by their appointment; that all books of history or any other book of state affairs shall be licensed by the principal secretaries of state, or one of them, or by their appointment; and that all books concerning heraldry, titles of honour and arms, or otherwise concerning the office of earl marshal, shall be licensed by the earl marshal, or by his appointment; and that all other books whether of divinity, physics, philosophy, poetry, or whatsover, shall be allowed by the Lord Archbishop of Canterbury or Bishop of London for the time being, or by the chancellors or vice-chancellors of either of the universities of this realm, for such books that are to be printed within the limits of the universities respectively, not meddling either with books of the common law or matters of state. All books coming from beyond the seas were to be reported by the merchant or consignee to the Archbishop of Canterbury or the Bishop of London, and to remain in custody of the custom-house officers until the archbishop or bishop sent one of his chaplains or some other learned man, to be present with the master and wardens of the Company of Stationers or one of them, at the opening of the bale or package, for the purpose of examining the books therein contained. And if any seditious, schismatical, or offensive book was found among them, it was to be

brought forthwith to the Archbishop of Canterbury or the Bishop of London, or to the High Commission Office. to be dealt with accordingly. All books, ballads, charts, and portraits were to bear the name of the printer or engraver as well as of the author or maker. All printers were to take out a licence. Their number was fixed and their names were published.

The war between Charles I. and the Parliament, and the abolition of the royal authority, did not affect the censorship, and the Long Parliament in the plenitude of its power maintained the practice just as the Star Chamber had done.

In March, 1642, an order of the Commons House of Parliament appointed by name certain stationers of London to search for any lying pamphlets scandalous to his majesty, or the proceedings of both or either House of Parliament, demolish and take away the printing-presses, and apprehend the printers or sellers.

In June, 1643, was issued an order of the Lords and Commons assembled in parliament for the regulating of printing, and for suppressing the great late abuses and frequent disorders in printing many false, scandalous, seditious, libellous, and unlicensed pamphlets, to the great defamation of religion and government. It enacts that no book, pamphlet, paper, nor part of any such book, pamphlet, or paper, shall from henceforth be printed, bound, stitched or put to sale by any person or persons whatsoever unless the same be first approved of and licensed under the hands of such person or persons as both or either of the Houses of Parliament shall appoint for the licensing of the same, and entered into the register-book of the Company of Stationers, according to the ancient custom. And further on it authorises or requires the master and wardens of the said company, the gentleman usher of the House of Peers, the sergeant of the Commons' House and their deputies, together with the persons formerly appointed by the committee of the House of Commons for examination, to make from time to time diligent search in all places where they shall think meet, for all unlicensed printing-presses, and all presses any way employed in the printing of scandalous or unlicensed papers, pamphlets, books, &c., and to seize, deface, and destroy the same in the Common Hall of the said company.

It was in consequence of this order that John Milton wrote his 'Areopagitica: a Speech for the Liberty of unlicensed Printing,' addressed to the Parliament of England, in which he shows that the system of licensing originated with the Papal Inquisition, and that it ought not to be adopted by a Protestant community: he exhibits its uselessness and injustice, and observes that the order of parliament is only a revival of the former order of the Star Chamber. Milton's disquisition is a piece of close reasoning and eloquently written; but it had no effect upon parliament, which continued to sanction the restraints upon the press, even after the abolition of royalty.

The parliament of 1654 appointed a committee to watch all blasphemous publications, on whose reports several books, religious or controversial, were ordered to be burnt.

The parliament of 1656 appointed a committee to consider the way of suppressing private presses and regulating the press, and suppressing and preventing scandalous books and pamphlets. The Protector Cromwell enforced these restraints, in order to prevent the agitation of political questions. In October, 1653, the council at Whitehall ordered that no person shall presume to publish in print any matter of public news or intelligence, without leave and approbation of the secretary of state. There appeared also an order of the protector and council against printing unlicensed and scandalous books and pamphlets, and for regulating printing. Cromwell however was disposed in general to rescue the victims of religious intolerance from the hands of their persecutors, the Independents and Presbyterians.

After the Restoration, Roger Lestrange was appointed licenser of printing. He wrote in 1663, 'Considerations and Proposals in order to the Regulation of the Press.' Lestrange seems to have retained his office till the revolution of 1688, when he was succeeded by Fraser, and he by Edmund Bohun.

The Act passed under Charles II., in 1662, which was, with few alterations, a copy of the Parliamentary ordinances concerning the licensing of printing, expired in 1679, but was revived by statute 1 Jac. II. c. 17, and continued till 1692. It was then continued for two years longer by statute 4 Will. & Mary, c. 24, and it expired in 1694, when the licensing system finally ceased in England. But the question of its revival was repeatedly agitated in parliament, as we see by a paper dated 1704, entitled 'Reasons against restraining the Press,' which deprecates the intention of reviving the licensing system; and by a much later and bolder pamphlet, dated 1729, styled, 'Letter to a Great Man concerning the Liberty of the Press.'

A relic of the old licensing system yet remains in the power of the Lord Chamberlain, or his deputy, the licenser of plays, to forbid the performance of any drama on the stage; but no attempt has ever been made to extend this power so far as to forbid the printing. Though, however, the power is very seldom exercised, it is still retained, and as recently as the spring of 1859, the representation of a drama ('Jack Sheppard'), which had passed uncensured for many years, was forbidden, and the command was unhesitatingly obeyed.

Under the old French monarchy, all works previous to being printed were to be examined by the royal censors, and if approved were signed with their permission. The French censorship was originally in the

hands of the bishops, for all matters concerning religion and ecclesiastical discipline. By degrees the bishops delegated this power to the faculty of theology, and the Parliament of Paris sanctioned the practice. In 1624, the faculty being divided into parties on some matters of controversy, Dr. Duval, the leader of one of the parties, obtained the king's letters patent for himself and three of his colleagues, by which they obtained the exclusive authority of approving of all books concerning religion and church discipline. The faculty remonstrated against this innovation, but the king maintained his appointment. After Duval's death, the faculty resumed its old powers; but in 1653, the controversy concerning grace having given birth to a multitude of polemical works, concerning which the faculty itself was divided in opinion, the chancellor Seguier took from it the censorship; and he created four censors, with an annual stipend, to examine all works without distinction. Before that time it appears that works unconnected with religion were examined by the Maitres des Requêtes. But from 1653, the appointment of the censors rested with the chancellor. They were styled Royal Censors, and their number was gradually increased. They were distributed into seven classes, according to the nature of the works which they had to examine; namely, theology, jurisprudence, natural history and medicine, surgery, mathematics, history and belles lettres (which class had the greatest number of censors attached to it), and lastly, geography, navigation, travels, and engravings. No work could be printed or sold unless it was previously examined and approved by one of the Royal Censors. The lieutenant of police had under him a censor who examined all dramatic works before they could be performed.

At the Revolution the censorship was abolished. The republican constitutions which were proclaimed in succession, acknowledged the principle of the liberty of the press; but amidst the struggle of parties, that principle was often overlooked, and journals and other works obnoxious to the ruling faction of the day were seized, and the authors or editors imprisoned and transported. Throughout the whole period of the so-called French republic, liberty existed in name, but not in reality. After the revolution of Brumaire, when Bonaparte was proclaimed First Consul of the French Republic, with powers more extensive than those of most kings, the question of the press attracted his early attention. No censorship was established by the consular constitution, but the newspaper press was left at the mercy of the executive. By a decree of the 27th Nivose, 1800, the number of newspapers at Paris was fixed, and the editors were forbidden to insert any article "derogatory of the respect due to the institutions of the country, the sovereignty of the people, and the glory of the French armies," or offensive to the governments and nations which were the friends and allies of France, even if such articles should be extracted from foreign journals, under pain of immediate suppression. The 'Moniteur' was announced to be the only official journal. Under Napoleon there was a committee of the Senate appointed to "protect the liberty of the press;" but the protection consisted in preventing either the printing or the publishing of anything contrary to the will of the authorities; although in 1806 it was declared that there existed no censorship in France,—that any French citizen could publish any book that he thought proper, being responsible for its contents before the tribunals, if charged with anything derogatory of the power of the emperor and the interests of the country.

In Napoleon's kingdom of Italy the censorship was likewise declared to be abolished, but on the day of the publication of a work two copies were to be deposited at the office of the Minister of the Interior. A commission, styled likewise "of the liberty of the press," examined the book and made its report to the minister, who, if he saw reason, stopped the sale of the work, and ordered the author or printer to be arrested and tried. Those who wished to avoid such risks were allowed to lay their manuscripts before the commission, which returned it with such corrections or suppressions as it thought advisable. This was called the facultative or optional censorship.

In 1809–10 there were discussions in the council of state respecting the laws of the press, which resulted in the decree of February, 1810, appointing a director-general of the press, with auditors, inspectors, and censors, under the control of the Minister of the Interior. The number of printers was to be fixed in every department; sixty was the number fixed for Paris. Printers, as well as booksellers, were to take licences and swear fidelity to their country and the emperor. Printers were forbidden to print anything derogatory of the duties of subjects towards their sovereign, or of the interests of the state. Parties offending were to be brought before the courts, and punished according to the Penal Code; besides which, the Minister of the Interior had the right of depriving the printer of his licence. Before setting up a work, the printer was to transmit the title of it, with the name of the author, if known, to the director-general, and likewise to the prefect of the department, declaring his intention to publish the work. The director-general could, if he chose, ask for the manuscript, and send it to one of the censors for examination. After the censor had made his report, the director would point out such alterations or suppressions in the text as he thought proper, and which became obligatory upon the author or printer, who however had the right of appealing to the Minister of the Interior, who forwarded the manuscript to another censor, who made his report to the director-general; and the director-general, assisted by other censors, decided finally upon the matter.

Authors or printers had the option of submitting their manuscripts to the examination of the censors previous to printing. But even after being examined, approved, and printed, a work could be seized and its sale stopped by the minister of police, who was however to forward it with his remarks within twenty-four hours to the council of state, which judged finally upon it. A well-known instance of this occurred with regard to Madame de Staël's book on Germany, which was seized after having been examined and printed, and the whole edition was destroyed. "Your book is not French, and we are not reduced to seek for models among the nations which you admire," was the minister of police's (Savary) reply to Madame de Staël's remonstrances on the subject.

Books printed abroad could not be imported into France without permission from the director-general.

The police had the censorship of dramatic works intended for the stage. Only one newspaper was allowed in each department, with the exception of Paris, subject to the approbation of the respective prefects. Such was the condition of the press in France during the latter years of Napoleon's empire.

At the first restoration of the Bourbons, in 1814, an article of the charter of Louis XVIII., acknowledged that "Frenchmen had the right of publishing their opinions by means of the press, conformably however to the laws enacted for the repression of any abuse of the liberty of the press." Soon after, the Abbé de Montesquieu, Minister of the Interior, procured the passing of a law by the chambers, by which all works consisting of less than twenty sheets were subjected to a previous censorship. A council of twenty censors was appointed. The office of director-general of the press was retained. Every printer was obliged to give notice of each work that he intended to print, and to deposit two copies of it, when printed, at the director's office, before he published the work.

When Napoleon returned from Elba, in 1815, he did not enforce the previous censorship, because, said he, they had published whatever they pleased against him under the Bourbons, and the matter was now exhausted. The other regulations however concerning printing and publishing were maintained, and the press and the emperor were often at variance during the hundred days. The previous censorship was temporarily re-established and abolished again under the second restoration of Louis XVIII. After Charles X. came to the throne, he abolished the previous censorship altogether, and by so doing he gained a momentary popularity with the Parisians. But the first of the ordonnances, signed the 25th of July, 1830, suspended the liberty of the periodical press; no journal was to be henceforth published without a special authorisation of the government, which was to be renewed every three months. All pamphlets or works under twenty sheets of letter-press, were made subject to the same authorisation. The ordonnances however were resisted, and the revolution of July was the result. The revised charter which was afterwards promulgated, 'Charte de 1830,' in its seventh article says, "Frenchmen have the right of publishing and printing their opinions, conformably to the laws. The censorship shall never be re-established." New laws, however, were enacted to repress the abuses of the press, among which the law of the 9th of September, 1835, embodies or refers to many of the former laws of the Empire and the Restoration. It specifies the crimes and misdmeanours committed by means of the press, and assigns the penalty to each. The proprietors of political journals are obliged to deposit a considerable sum in the treasury as a security for their good behaviour. One hundred thousand francs (four thousand pounds sterling) is the deposit required for a daily Paris newspaper, and one half the sum for a weekly paper.

Little alteration, or at most only for a short time, was made by the revolution of 1848. Under the empire the previous censorship of all works below a certain size still exists. The deposition of a large sum before the publication of a newspaper is still required; and a specially appointed minister has the power of warning a newspaper of having committed an offence, and the issuing of three such warnings is to be followed by suppression. Works after publication may be seized, and their sale forbidden; and foreign works and newspapers are liable to be seized at any time on the order of this minister.

The absolute monarchies of Europe, Russia, Austria, Prussia, and the Italian States, retain the obligatory previous censorship of the press, which is derived from the very principle of their government, that of parental authority over their subjects. In some of the Italian States (Rome and Naples, for instance) there is a double censorship; one by an ecclesiastical and the other by a political censor. But even then it happens sometimes that after a work has passed the censorship and obtained the "imprimatur," something obnoxious is discovered which had escaped the censor's penetration, and the book is seized and confiscated.

In the republics of Switzerland, the censorship existed before the organic changes which have taken place in most of the cantons since 1830. All previous censorship is abolished; but the laws in some of the cantons are very restrictive of the liberty of the press, and especially of the newspaper press, on matters of religion. Generally speaking, the press is freest in the Protestant cantons.

The liberty of the German press varied according to the spirit of the different governments. As early as 1570, by a decree of the empire, printing-presses were only permitted in towns which were the

residences of sovereign princes; and every printer was required, if called upon, to take an oath to print only what was just, honourable, and altogether fitting. During the Thirty Years' War an universal freedom prevailed; but on the conclusion of the Peace of Westphalia, the "massacre of the press" was again a matter of complaint. In Saxony, Prussia, Hanover, and the Free Towns considerable freedom was allowed, while in Austria and Bavaria the regulations were very stringent; and in all it depended on the government, and was nowhere recognised as an inalienable right of the people. During the war which ended in the downfall of Napoleon, reforms of all kinds were promised to the people, and especially freedom of the press. This promise was very imperfectly fulfilled, but the censorship was removed in several of the minor states. The political agitation of Europe after the downfall of Napoleon, however, caused the German rulers to hold a congress at Karlsbad in 1819, by which the German periodical press was enslaved by the decision that all books or other printed publications under twenty sheets should be subjected to a censorship. The spirit which directed this censorship was most arbitrary and harsh, and led to collisions of the most dangerous kind between the representative bodies of the state and the rulers. Nor was the liberty of the press for books above twenty sheets respected, and political authors especially experienced many persecutions, while strangely enough religious matters might be treated with perfect freedom.

After the French revolution of 1830, the people of Germany rose in arms, demanding constitutional rights, and above all a free press, and the rulers were in some states compelled to grant their claims. Again, however, when the people had been quieted, measures were taken to revoke all these privileges. On June 28, 1832, the Diet resolved that care should be taken to compel the editors of newspapers and other political productions to keep within proper limits in publishing the debates of the representative bodies; and the Diet of 1836 declared that editors of newpapers and political writers should publish no account of such debates, except those published in the government papers, or extracts from them. Since that time there has been a visible reaction against the freedom of the press, though the censorship is much more severe against political and historical publications than against other works. During the revolutionary disturbances in Germany in 1848, the first demand, in almost every country where a rising took place, was for an emancipation of the press from its restrictions. It was uniformly granted, and it was voted by the Bundes Versammlung in the sitting of March 3. Even Austria agreed to it, with a promise that the censure should not be again established; and throughout Germany the only requisition was that the printers' and publishers' names should be always printed, and that they should be answerable for infractions of law. But as early as March, 1849, Austria set the example of abrogating these privileges; the other states lost no time in following it, and by the end of 1850 the old system of censorship and supervision had been thoroughly restored. In Austria the newspaper press is under the direct control of the government; and in Prussia a large deposit is required before a newspaper can be published, and the minister has the power of appointing a working editor.

By the Spanish constitution of 1837, "all Spaniards may print and publish their thoughts freely, without previous censorship, but subject to the laws. The determination of offences by means of the press belongs exclusively to juries empanelled for that purpose;" but this regulation, always imperfectly observed, was superseded by a law passed in 1850, and though by it no previous censorship was established, books and newspapers are liable to be seized if they contain anything offensive to the government.

The constitution of Portugal establishes no previous censorship, but refers to the laws for repressing the abuses of the press.

By the constitution of the kingdom of Greece of 1827, "the Hellenes have the right of publishing freely their thoughts by means of the press, abstaining however,—1, from attacking the principles of the Christian religion; 2, offending decency and morality; 3, indulging in personal insult and calumny."

The Swedish constitution of 1809, promulgated under King Charles XIII., enacts that the states of the kingdom in every new Diet shall appoint a committee of six members, well informed persons, among whom must be two jurists, for the purpose of maintaining the liberty of the press. The committee will examine all MSS. which shall be laid before it by any author or bookseller; and if the committee declares that the work is fit to be printed, the author and publisher are thenceforth discharged from all further responsibility. The Chancellor of Justice of the State is by right President of the Committee. But this is a voluntary, and not an obligatory, previous censorship. Persons guilty of libel and other offences by means of the press are tried by a jury. By a law enacted by the Diet in 1812, a newspaper which insults or defames a foreign government friendly to Sweden, is liable to be suppressed by order of the chancellor, without any other formality. This has occurred repeatedly, but then the paper appears again the next day under a slightly altered title; for instance, the Argus is suppressed, but is continued under the title of Argus II. or Argus III.

The constitution of Norway proclaimed in the Storthing of Eidswold, November, 1814, enacts that no one shall be prosecuted for his printed writings, unless he wilfully and evidently manifests or encourages others to manifest disobedience to the laws, contempt for religion, morality, or the constitutional powers, or resistance to the constitu-

tional authorities, or is guilty of defamation and libel against any one, in which case he shall be fined by the tribunals.

The constitution of the Netherlands of 1815, which is still in force in the kingdom of Holland, says, Art. 227, "the press being the fittest means to spread knowledge, every one has a right to make use of it to communicate his thoughts, without needing previous permission. But all authors, printers, editors, or publishers, are answerable for those writings which attack the rights either of society or of individuals."

By Art. 18 of the constitution of Belgium, the press is declared to be free; no censorship can ever be established. Authors, editors, and printers are not required to give security. Offences committed through the press are tried by the ordinary courts.

In Denmark, an ordinance of Christian VII., dated September, 1799, on the subject of the press, abolishes the previous censorship, but imposes severe penalties on those who offend through the press; death is the penalty for any person who shall excite rebellion or provoke a fundamental change in the constitution of the monarchy. Whoever censures or defames or excites hatred or contempt against the constitution of the kingdom and the government of the king, either on general grounds or on the occasion of any particular act, shall be banished for life; and if he returns without permission, shall be sent to hard labour for life. Whoever shall censure or vilify the monarchical form of government in general shall be exiled from three to ten years. Any libel against the person and honour of the king, or any member of the royal family, shall be punished with exile. Whoever publishes a work tending to deny the existence of God, or the immortality of the soul, or to cast censure or ridicule on the fundamental dogmas of the Christian religion, is to be banished likewise. Any one who shall attack or ridicule the tenets of the other Christian communions tolerated in the kingdom, shall be punished by a short imprisonment on bread and water. The same punishment is assigned to those who shall offend public morals by their writings. Any one defaming a foreign prince friendly to Denmark, or ascribing to his government any unjust or disgraceful act, without quoting any authority, shall be sent to hard work in a house of correction for a limited period.

The constitutions of the various states composing the North American Union, admit the absolute liberty of the press. There is, of course, in each State a law of libel sufficiently strict. In the slave States there are very severe laws against interfering by the press with the great question of slavery. It has been stated that abolitionist newspapers are seized at the post-office.

The republics of Spanish America likewise acknowledge the principle of the unfettered liberty of the press, however often it may have been violated in practice amidst the never-ending factions and civil wars of those countries. The constitution of the Brazilian empire establishes the freedom of the press without any censorship; but an author is liable to punishment in such cases as are provided by law.

CENSUS, THE, at Rome, was a numbering of the people, and a valuation of their property. It was held in the Campus Martius. (Liv. iv. 22; Varro 'de R. R.' iii. 11.) Every Roman citizen was obliged, upon oath, to give in a statement of his own name and age, of the name and age of his wife, children, slaves, and freedmen, if he had any. The punishment for a false return was, that the individual's goods should be confiscated, and he himself scourged and sold for a slave. Taxation depended on the results of the census; many kinds of possessions and of actual property were excepted, while, on the other hand, some sorts of property were assessed at several times their value. Constant changes were made by successive censors in the valuation of taxable property. Cato and Flaccus rated the taxable value of high-priced slaves at ten times the purchase-money. (Nieb., vol. ii. p. 402.)

According to the valuation of their property at the census, the citizens were divided into six classes; each class contained a number of centuries or hundreds. That a century did not always consist of a hundred men is clear, from the fact that the richest centuries were the most numerous, and consequently must individually have contained fewer persons than the centuries of the poor. The first class consisted of those whose property amounted to 100,000 *ases*, about 322*l.* 18*s.* of English money; the second class consisted of persons worth 75,000 *ases;* the fortune of the third class amounted to 50,000 *ases;* that of the fourth to 25,000; that of the fifth to 11,000; and the sixth class included all below the fifth, even those who had no estate whatever. This was naturally the fullest of the six, but was accounted only as one century. Now, as the richer classes contained far more centuries than the poorer, so much so that the first class contained more than all the rest together, and as the votes in the *Comitia Centuriata* were taken within the centuries individually, and then the voice of the majority of centuries was decisive, it is obvious that the influence of wealth was greatly preponderant in this assembly. Cicero ('De Repub.' ii. 22) assigns this as the object aimed at in the institution. The real object of the *Comitia Centuriata* was (as Niebuhr supposes) to bind the different orders of the state together in one consistent and organised body. Every one in the nation had a vote on national business; and in this assembly was laid the basis of popular liberty. In the *Comitia Centuriata* the people always appeared under arms, and each class had a particular kind of armour assigned to it.

The census was held at first by the kings, afterwards by the consuls; and, from A.U.C. 311, by the censors. After the census a sacrifice of purification was generally, but not always (Liv. iii. 22), offered. The victims were a sow, a sheep, and a bull, which were led thrice round the army, and then slain: the sacrifice was called *Suovetaurilia*.

It does not appear that the census was held with strict regularity. It was sometimes altogether omitted. (Liv. iv. 8; Cic. 'pro Arch.' 5. 11.) The usual interval was five years; and in allusion either to the sacrifice of purification, or to the farmers paying their taxes at this time (Voss. 'Etymolog. Ling. Lat.' *in lustrum*), the interval was commonly called a lustre (*lustrum*). It is obvious that the census must have been of great use in ascertaining the actual strength and capabilities of the state.

When a person was duly entered on the books of the censors, this was taken as a proof of his citizenship, even if he were a slave, provided he had been registered with his master's consent (Cic. 'de Or.' i. 40; Ulp. i. 8); but many enactments were made to regulate and modify this legal principle. As the census was held at Rome, citizens who were in the provinces, and wished to be registered, were obliged to repair there on that occasion (Cic. 'ad Att.' i. 18, &c.); but this was sometimes evaded, and was made a matter of complaint by the censors. The census, accompanied with the ceremony of the *lustrum*, seems to have fallen into disuse after the time of Vespasian; but the numbering of the population, &c., continued till a late epoch of the empire.

As to the census in the provinces, under the empire, see Tacitus ('Ann.' i. 31, 33, &c.), and the 'Excursus' of Lipsius. See also 'Dig.' 50, Tit. 15.

The term *census* is also used in Latin authors to signify the amount of a person's estate; and hence we read of *census equester*, the estate of an eques, and *census senatorius*, the estate of a senator. (Pitisc. 'Lex. Antiq. Rom.)

CENSUS OF THE UNITED KINGDOM. The first attempt to ascertain the population of England, and to determine its increase or otherwise, by ascertaining the number of births and burials, was made at the beginning of the 18th century. This method could at best afford merely an approximation towards the truth, which can only be satisfactorily ascertained by actual enumeration; while as regards many other important questions connected with the condition of the people, it is clear that deductions drawn from registers of births and burials, if even they were perfectly accurate (and up to 1839 they were very far from being so), would give no information whatever.

The first actual and official enumeration of the people of England and Scotland was made in 1801, and subsequently in 1811, 1821, 1831, 1841, and 1851. In Ireland the earliest enumeration was made in 1813, since which time a census has been taken, as in Great Britain, in each of the years 1821, 1831, 1841, and 1851. It will be sufficient here to give first a summary of the returns of 1821, 1831, and 1841, being the earliest in which Ireland is included at the same period, and then the details of that of 1851, which embodied a number of inquiries that were unattended to in the preceding censuses.

	1821.	1831.	1841.
England	11,486,700	13,091,005	14,995,138
Wales	731,800	806,182	911,603
Scotland	2,135,300	2,365,114	2,620,184
Army, navy, and registered seamen afloat	Included in the above.	277,017	188,453
Persons travelling on the night of June 6		..	5,016
Islands in the British Seas		103,107	124,040
Great Britain	14,353,800	16,643,028	18,844,434
Ireland	6,846,949	7,767,401	8,175,124
United Kingdom	21,200,749	24,410,429	27,019,558

As we have already stated, the census of Great Britain in 1851 differed in several respects from any previous census. In some points the range of its inquiries was more minute and precise; in many others wider and more comprehensive. The words of the elaborate Report of the Registrar-General, prefixed to the volumes of Population Tables, printed by order of Parliament, will best indicate what the census of 1851 sought to accomplish:—

"At the present census it was resolved to exhibit not merely the statistics, as before, of parishes, and, more completely, of parliamentary and municipal boroughs, but also of such other large towns in England and Scotland as appeared sufficiently important for separate mention, and of all the ecclesiastical districts and new ecclesiastical parishes which, under the provisions of various Acts of Parliament, have, during the last forty years, been created in England and Wales. In addition also to the inquiry concerning the occupation, age, and birthplace, of the population, it was determined to ascertain the various relationships (such as husband, wife, son, daughter)—the civil condition (as married, unmarried, widower, or widow)—and the number of persons blind, or deaf and dumb. Further, under the impression that the fifth section of the Act would authorise such an inquiry, the design was formed of collecting statistics as to the accommodation afforded by the various churches and other places of public religious worship throughout the country, and the number of persons generally frequenting them; and also as to the existing educational establishments, and the actual number of scholars under instruction. It was, however, subsequently

considered doubtful whether, upon a rigid construction, the Census Act rendered it compulsory upon parties to afford information upon these particulars; and the inquiry was therefore pursued as a purely voluntary investigation."

For obtaining these objects, the local machinery introduced in England and Wales by the Poor Law and Registration Acts was employed, the general direction of the census, under the Secretary of State, being given to the Registrar-General. The 624 Registration Districts, into which England and Wales was divided by the Registration Act, each having a superintendent-registrar, were subdivided into 2190 subdistricts, each having a local registrar of births and deaths. These subdistricts were, for the purposes of the census, and under the supervision of the registrars and superintendent-registrars, again divided into 30,610 enumeration districts, each such district being assigned to one enumerator, who was required to complete his enumeration in *one day*. In Scotland, where no such local machinery existed, the census was taken through the agency of the sheriffs of counties and chief officers of boroughs; the working of the act being devolved chiefly on the sheriffs-substitute, "who appointed a fit person, generally the parochial schoolmaster, in each parish to divide it into convenient enumeration districts, and superintend the proceedings of the census therein." The number of enumeration districts formed throughout Scotland, in 1851, was 7873; in the islands of the British seas, 257 enumeration districts were similarly formed. Of the mode of taking the census, it will suffice to say, that blank forms were left at every house and public institution, with minute directions, in order that they might be correctly filled up with the requisite information concerning every person who abode in the house or apartment on the night of March 30, 1851. These forms were collected by the enumerators on the 31st of March; each enumerator being directed to satisfy himself, as far as possible, of the accuracy of the entries, and where inaccurate to correct them.

The vast importance of the method adopted, as a security for the accuracy and precision of the returns, will be best understood by a comparison with the method adopted in taking the Census of the United States in 1850. At that date the territory of the United States comprised an area of 3,300,000 square miles. To number the inhabitants occupying that vast space the entire staff of superior and subordinate officers employed numbered only 3276 persons,—less than one-tenth of the number employed for enumerating the population of England and Wales, a territory of 58,320 square miles, or less than a fifty-sixth of the area of the United States. It is at once evident that the American enumeration could not be made on one day, and accordingly we find that though the schedules were directed to be filled up with "reference to" a particular day, the officer did not call at the house, the inmates of which were to be numbered, till some days, weeks, or even months after the time specified; when—the careless way in which people are accustomed to treat such things being taken into account—it is scarcely possible that errors can in very numerous instances be avoided, even as regards the mere number of residents, while in respect of age and other more minute matters, the probability of error is of course largely increased.

As far as provision could be made by the strength and careful appointment of the official staff, and the strictness with which their duties were defined, the arrangements for the British Census of 1851 were in all respects admirable, and probably the returns were as accurate as under existing circumstances are attainable. It may serve to show the amount of labour which devolved on this army of enumerators (including Scotland, nearly 39,000 in number), to state that the blank-forms for England and Scotland, issued from the Census Office, amounted in all to nearly 7,000,000, the weight of them being nearly 40 tons: the "weight of the schedules, blank enumeration books, and other forms, despatched from the central office, exceeded 52 tons." The schedules, after being duly filled in, were subjected to revision by the registrars and superintendent-registrars before transmission to the Census Office, there to undergo final revision and generalisation. The enumeration of the persons on board vessels, either in harbour or at sea, was accomplished by the officers of the Customs, the Admiralty, and the Registrar of British Seamen; the enumeration of the army by the officers of the various branches, under the direction of the Commander-in-Chief. In these, as in other matters, the returns were much more minute and extensive than in any previous census; while several collateral returns were at the same time obtained, such as of the latest population of the several colonies, the number of British subjects in various foreign states, the number and rank of half-pay officers of the army, navy, and marines, of Chelsea and Greenwich pensioners, of officers employed in the civil service of the crown, &c.

The household schedules were collected on the 31st of March, and subjected, as mentioned, to revision by the registrars and superintendent registrars. "By the end of the month of May, these schedules, amounting to about 4,300,000 distinct returns, and the enumeration books 38,000 in number, were received at the central office. The result of the enumeration having been obtained from the summaries forwarded with the returns by the registrars in England and Wales, and the numbers for Scotland also ascertained, a statement of the total population and number of houses was transmitted, on the 7th of June, to the Secretary of State, and at once made public." Having mentioned the quantity of labour which devolved on the large army

of enumerators, it is only fair to add, as an evidence of its vast amount, as well as the scrupulous care with which the subsequent proceedings were conducted, that every total and summary throughout the enumerators' returns was subjected to strict and minute examination for the purpose of verification or correction; such revision alone involving "the examination and totalling of more than 20,000,000 of entries, contained on upwards of 1,250,000 pages of the enumeration books." This revision was entirely preparatory to the great work—the classification of facts.

We proceed now to the *Results* of the enumeration of the population. Stated in a single sentence, the great result of the enumeration, as given in the census of 1851, is, that Great Britain, without including the islands in the British seas, contains 13 divisions, 84 counties, 696 districts, 17,150 parishes or places, 38,483 enumeration districts, 3,648,347 houses, 20,816,351 inhabitants, and 57,372,377 acres.

The *Population* of Great Britain, including the islands in the British seas, on March 31, 1851, was 20,959,477; and the men in the army, navy, and East India Company's service, abroad, on the passage out, or round the coast, belonging to Great Britain, on the same day, was 162,490. The total population of Great Britain may therefore be set down at 21,121,967. Of these, 16,921,888 were in England; 1,005,721 in Wales; 2,888,742 in Scotland; 143,126 in the Isles of Man, Jersey, Guernsey, Alderney, and other small islands in the British seas; and 162,490 were at sea or serving abroad in the army.

The *Proportion of Males to Females* has been preserved with remarkable regularity during the half century. In 1851 the male population of Great Britain was 10,386,048, the female 10,735,919; being an excess of 349,871 females: the excess of females at home was 512,361. The proportion in 1851 was 103,369 females to every 100,000 males; in 1801 it was 103,353 females to 100,000 males. At both periods there were somewhat less than 30 males to 31 females. In 1851 there were 20 males at home to 21 females. The excess of births, however, is in the opposite direction. During the thirteen years (1839-1851) in which accurate registers of births have been kept, there have been born 3,634,235 males and 3,465,629 females, or about 105 males to every 100 females (104,865 to 100,000). The disparity in the sexes at home is greatest in Scotland—110 females to 100 males; in England and Wales it is only 104 females to 100 males. To what degree the change in the proportions and the subsequent disparity of the numbers in the two sexes is due to emigration, or to a difference in degree of the dangers and diseases to which they are respectively exposed, this is not the place to consider.

The *Increase of Population* in the last half-century nearly represents a new nation equal to that which existed in Great Britain at its commencement, and that notwithstanding the vast numbers who have "annually left the United Kingdom, settled and multiplied into millions in the United States, in the colonies of North America, of Australia, and of South Africa." The aggregate increase in the fifty years is 93·470 per cent., or at the rate of 1·329 per cent. annually. "The annual increase, however, has varied in each decennial period; it increased from 1·274 per cent. on the population in 1801-11, to 1·489 (nearly 1½) in 1811-21, when it was at the *maximum*; the annual rate of increase in 1821-31 was 1·408; in 1831-41 it fell to 1·279; and in 1841-51 to 1·186 per cent. annually. The population therefore is increasing, but the rate of increase has declined since 1811-21, when there was little emigration, and the mortality in England was lower than it has ever been before or since, down to the two last decennaries; when the public health has suffered from epidemics of influenza, cholera, and other diseases, while emigration from the United Kingdom has proceeded at an accelerated rate from 274,300 in 1821-31, to 718,000 in 1831-41, and 1,693,000 in 1841-51." During the same period the proportion of land to each person has decreased in Great Britain, from 5·4 acres in 1801, to 2·7 acres in 1851; from 4 acres to 2 acres in England and Wales.

If the rate in which the population has increased since 1801 continue to prevail uniformly, the population would double itself in Great Britain every 52½ years; in England and Wales every 51 years.

The number of *Families* in Great Britain in 1801 was 2,260,802; in 1851 it was 4,312,388; being an increase of 2,051,586. The families in England and Wales in 1801 were 1,896,723; in 1851 they were 3,712,290. In Scotland they were 364,079 in 1801, and 600,098 in 1851. The average number of families to a house in Great Britain in 1801 was 1·209, and of persons in a family, 4·645; in 1851 there were 1·182 families to a house, and 4·825 persons in a family. In Scotland in 1851 the average of persons in a family was 4·814, or nearly that of the whole island; but the average of families in a house was somewhat higher—1·621. In Glasgow the number of families to a house is 5·4; of persons to a house, 27·5; in Edinburgh the corresponding numbers are 4·2 and 20·6; in Aberdeen, 3 and 12·3; in Dundee, 3·2 and 15·7; in Perth, 2·8 and 12. In London, on the other hand, the numbers are only about the average of Scotland—1·74 and 7·7; but in some districts they are as high as 10, 11, and even 12 persons to a house. This excess in the northern cities was caused by a real difference in the habits of the people. "The towns and cities of the two northern English counties and of Scotland are built in the continental style; and the families of the middle classes, as well as the poor, live in large flats, which constitute separate tenements." The term house, in many parts of Scotland, has been usually applied to

these several flats or floors; and in every census from 1801 to 1841, "flats" in Glasgow and some other Scottish towns were returned as separate houses. In 1851 this was corrected, and the enumerators were instructed that flats and sets of chambers must not be returned as houses. The returns from Scotland, as from England, are now, therefore, made on a tolerably uniform principle, and are fairly available for comparison. The variations in the several English counties and in different districts with respect to the proportion of families to houses is considerable; but it would require far more space than we can spare to enter upon it. As a rule, in England and Wales, a house is inhabited by one family, the excess in the proportion being mainly caused by the large number of public institutions, hotels, lodging-houses, &c. The following is an analysis of the families in connection with the houses which they occupy in 14 subdistricts of England containing 35,876 inhabited houses, in which were 48,985 families (1608 of the houses having the families absent), comprising 242,164 persons, or, on an average, nearly 7 persons to a house—5 to a family. Of these houses, 26,309 contained one family; 4,789, two families; 1523, three; 748, four; 425, five; 224, six; 118, seven; 62, eight; 32, nine; and 38, ten families and upwards. This analysis is in the Report carried out with great minuteness into a variety of particulars, but which it is impossible for us here to follow.

The number of *Houses* in Great Britain in 1851 was—inhabited, 3,670,192; uninhabited, 166,735; building, 29,194. In 1801 there were 1,882,476 inhabited, and 67,320 uninhabited; the number building was not returned. The following tables show (1) the number of principal public institutions,—of their inmates 35,516 were officers and servants; and (2) the number of persons sleeping in barges, barns, tents, and vessels.

Institutions.	No.	Persons.	Males.	Females.
Barracks	174	53,933	44,833	9,100
Workhouses	746	131,582	65,786	65,796
Prisons	257	30,959	24,593	6,366
Lunatic Asylums	149	20,004	9,753	11,251
Hospitals for the sick	118	11,647	5,893	5,754
Asylums and other charitable institutions	573	46,731	27,183	19,548
Total	2,017	295,856	178,041	117,815
Persons in barges		12,924	10,395	2,529
,, barns		9,972	7,251	2,721
,, open air in tents		8,277	4,614	3,663
,, vessels in the ports engaged in inland navigation		8,575	7,730	845
,, sea-going vessels in the ports		43,173	41,165	2,008
Total		82,921	71,155	11,766

"The enumeration of the *Houseless Population*, unsettled in families, is, however, necessarily imperfect; and the actual number must exceed the 18,249 returned, namely, 9,972 in barns, and 8,277 in the open air. It is mentioned in one instance that a tribe of gipsies struck their tents and passed into another parish in order to escape enumeration. In 1841 the number of the houseless class was 22,303; owing to the more advanced period of the year (June 7) at which the census was taken, many Irish people and labourers were then engaged in the hay harvest."

From houses and families we ascend to *Towns and Corporations*. No attempt was made to classify the smaller aggregates of houses, by defining villages, hamlets, &c.; but 17,150 places which have defined boundaries are separately returned in the Population Tables, and each of these is assumed to be a *village*, or an aggregation of families round a church or chapel; on an average these villages lie at a distance of about 2½ miles apart, so that the inhabitants of the country around them, distributed over an area of 5 miles, lie at the average limit of 1¼ mile from the centre, or at the mean distance of six-sevenths of a mile.

"Great Britain has *eight hundred and fifteen* towns of various magnitudes, either market towns, county towns, or cities; *five hundred and eighty* in England and Wales, *two hundred and twenty-five* in Scotland, and *ten* in the Channel Islands. To 21 of the preceding 'villages' there is on an average a town, which stands in the midst of 110 square miles of country, equivalent to a square of 10½ miles to the side, a circle having a radius of nearly 6 miles; so that the population of the country around is, on an average, about 4 miles from the centre.

"The population amounted to 10,556,288 in the 815 towns, which stand on 3,164 miles of area. An average town of 12,953 inhabitants, stands on an area of nearly 4 square miles; equivalent to a square of 2 miles to the side, a circle 1$\frac{1}{10}$th mile radius, and the population is less than three-quarters of a mile from the centre.

"The population in the rest of Great Britain was 10,403,189; consequently if, for the sake of distinction, the detached houses, the villages, and small towns without markets, are called—country; at the present time the *town* and *country* populations of Great Britain differ so little in numbers, that they may be considered equal; for, by the abstracts, 10,556,288 people live in the towns, and 10,403,189 in the country. In the towns there were 5·2 *persons to an acre*, in the country 5·3 *acres to a person*. The density in the country was 120 persons—in the towns 3,337 persons—to a square mile. . . .

"The 815 towns are grouped around 87 county towns—52 in England, 32 in Scotland, and 3 chief towns, equivalent to county towns, in the Islands of the British Seas. Each of the central county towns was surrounded on an average by eight or nine other towns, extending over an average area of 1,067 square miles, equivalent to a square of 33 miles to the side; a circle of 18 miles radius; and without allowing for the extreme distance of the Islands in the British Seas they were 35 miles apart. The population of the county towns of Great Britain, and the chief towns of the Channel Islands amounted to about 626,547 in 1801, and to 1,391,538 in 1851; in England and Wales the population of the county towns was about 473,239 in 1801, and 1,076,670 in 1851.

This equality of proportion between the town and country population of Great Britain is one of the "great facts," brought into prominent notice by the present census. The great relative increase of the population collected in the principal towns is another of the more important facts which point to a change in the habits and condition of the people. Thus, in the 61 principal towns in England and Wales, which in 1801 contained 2,163,698 inhabitants, the population had risen in 1851 to 6,254,251; in other words, in 1801, about 24 per cent. of the entire population resided in those 61 towns, while in 1851 very nearly 35 per cent. of the population resided in the same towns. In the seven principal towns in Scotland there resided in 1801, 271,486 out of the entire population of 1,608,420, or 16·8 per cent.; in 1851, 779,698 out of the entire population of 2,888,742, or 26·9 per cent.: or there occurred a relative increase in the 68 largest towns in Great Britain of upwards of 10 per cent., as compared with the increase of the entire population: that is, whereas then *two* of every *ten* persons in Great Britain resided in 68 of the principal towns, now *three* out of every *ten* persons reside in them. The increase of the population of London and the other great towns was 4,609,525, or 189 per cent. in the half-century; that of the smaller towns and the country was 5,770,996, or 71 per cent. The actual increase in some of the great towns was very remarkable. In London the population increased from 958,863 to 2,362,236, being an increase of 1,403,373, or 146 per cent.; Manchester (with Salford) from 94,786 to 401,326; Liverpool from 82,295 to 375,955, its opposite neighbour Birkenhead rising in the same time from 110 to 24,285; Birmingham from 70,670 to 232,841; Preston from 12,174 to 69,584; Bradford from 13,264 to 103,778; Plymouth from 16,040 to 52,221; Southampton from 7,913 to 35,305; Merthyr Tydfil from 10,127 to 63,080; Glasgow from 77,058 to 329,007; and other manufacturing, mining, and sea-port towns at a proportional rate. The increase in the population of the watering-places, or towns chiefly devoted to pleasure, meanwhile being at least commensurate with that of the towns devoted to business: thus Brighton increased from 7,440 in 1801, to 69,673 in 1851; and Cheltenham from 3,076 to 35,051.

Dividing the towns into classes, it appears that "the greater part (3,022,776) of the increase (5,363,650) in the six classes of towns, was in London and in the manufacturing towns; the (1) sea-ports, the (2) towns which are in mining districts, or are engaged in hardware manufactures, and (3) the county towns, severally contributed more than three-quarters of a million to the increase; the increase of the people living in watering-places was 200,164. In the latter class the rate of increase was the greatest; it was 2·561 per cent. annually. The annual rate of increase was 2·380 in the manufacturing towns, 2·336 in the mining and hardware towns, 2·191 in the sea-ports, 1·820 in London, and 1·609 in the county towns. The annual rate of increase in Great Britain during the same half-century was 1·377. The towns have increased most rapidly in which straw-plait, cotton, pottery, and iron are manufactured."

The *Density* and *Proximity* of the population are elucidated in the Report and the Summary Tables in various ways, and at considerable length: here, however, the matter must be treated briefly. The density of population, or, as a recent French authority (Baron de Prony in the 'Annuaire') has proposed to term it, the "specific population," after the analogy of "specific gravity," varies in the 624 districts of England and Wales, from 185,751 persons on a square mile in the East London district, to 18 on a square mile in that of Bellingham, Northumberland. The greatest density of population out of London is in the Liverpool district, which is 74,446, and the next Birmingham, which is 41,853 on a square mile. Manchester has 11,577, which is less than Leeds, which has 30,886; Bristol, which has 22,858; Plymouth, which has 20,441; Nottingham, which has 19,994; East Stonehouse, which has 19,913; Brighton, which has 18,088; Hull, which has 17,750; Salisbury, which has 11,907; Greenwich, which has 11,849; and Exeter, which has 11,670. The smaller density of Manchester than such towns as Salisbury and Exeter is accounted for in a great measure, by the large spaces covered by the numerous great factories and warehouses; yet the result is scarcely what would be generally expected, especially as both Exeter and Salisbury are cathedral towns, having considerable open spaces within the city boundaries. But the evidence of overcrowding in these two cities appears much stronger when they are compared with some of the other most populous manufacturing towns: Sheffield, for instance, which is among the densest, has 6263, or little more than half as many on the square mile as Salis-

bury; Bradford, which has 2887, or less than one-fourth; and Blackburn, which has 1333, or only one-eighth. As respects proximity of population, regarding it upon the same hypothesis of equal distribution, we find that the people of England were, in 1801, on an average 153 yards asunder, while in 1851 they were only 108 yards asunder; the mean distance apart of the houses in 1801 being 362 yards, and 252 yards in 1851. Or, as it may be otherwise expressed, on the same area the population has doubled—the proximity has increased—the separation has diminished—in the ratio of 3 to 2. In the London division the mean proximity has increased from 21 yards in 1801 to 14 yards in 1851. The following table shows the density and proximity of population in the eleven divisions of England and Wales in 1851, which are arranged according to the order of density :—

		Yards asunder of People.	To a Square Mile. Persons.	Houses.
I.	In London	14	19,375	2,509
VIII.	„ North-Western Division (Cheshire and Lancashire) . . .	67	792	139
VI.	„ West-Midland Division . . .	100	355	70
IX.	„ Yorkshire (nearly the same as all England)	107	313	63
II.	„ South-Eastern Division . . .	118	256	47
III.	„ South-Midland Division . . .	120	247	49
V.	„ South-Western Division . .	124	231	43
IV.	„ Eastern Division	127	222	46
VII.	„ North-Midland Division . .	128	220	45
X.	„ Northern Division	142	178	30
XI.	„ Welsh Division	157	149	29

"The divisions in which the line of proximity is less than 108 yards have a large proportion of town population; the divisions, of which the line of proximity exceeds 127 yards, contain forests, wastes, fens, or mountains."

The *Islands of the British Seas* are noticed more fully in this than any previous census. Five hundred islands and rocks have been numbered; but inhabitants were only found on the morning of March 31st, 1851, in 175 islands, or groups of islands. Some of the others are, however, occasionally dwelt on by shepherds during summer. Passing over Ireland, which contained 6,551,970 inhabitants, we find that four of the larger islands have each upwards of 50,000 inhabitants:—Anglesey 57,318, Jersey 57,020, Isle of Man 52,344, Isle of Wight 50,324. Four others have each above 20,000:—Guernsey 29,757, Lewis 22,918, Skye, 21,528, and Shetland 20,936. Two more number upwards of 10,000:—Orkney 16,668, and Islay 12,334. Twenty number between 1000 and 10,000 inhabitants; fifteen between 500 and 1000; thirty-seven between 100 and 500; fifteen between 50 and 100; forty-five between 10 and 50; seven number 10 inhabitants on each; and twenty-five under 10, two of them having only one inhabitant on each, Little Papa, one of the Shetlands, a woman, and Inchcolm, in Fifeshire, a man. Some of the more remote and smaller islands were now numbered for the first time, and much curious information was collected.

The number of *Boroughs* in England and Wales having municipal organisation according to the Municipal Reform Act, was 196, with a population of 4,345,269; of these boroughs, 18 have had charters of incorporation granted since the passing of that Act. There are 89 unreformed boroughs. Of the reformed boroughs it is found that one-half of the population (2,220,542) is contained in 17 boroughs, each of which contains more than 60,000 inhabitants. It appears also that 102 boroughs, or more than half of the total number, contain less than 9,000 inhabitants in each; in the aggregate, 472,551 inhabitants. Eighty-seven boroughs have from 2,000 to 7,000 inhabitants; twenty-seven, from 20,000 to 40,000; eight, from 40,000 to 60,000; seven, from 60,000 to 80,000; two, from 80,000 to 100,000; and three have 200,000 and upwards.

The 83 royal and municipal burghs of Scotland contained 752,777 inhabitants; only three burghs contained more than 60,000 inhabitants; one, more than 40,000; three, from 20,000 to 40,000; fifteen, from 7,000 to 20,000; thirty-three, from 2,000 to 7,000; and twenty-eight under 2,000 inhabitants.

Several of the most populous and important places in England and Wales are still without a municipal organisation. Among these are the metropolitan parliamentary boroughs of the Tower Hamlets, population 539,111; Finsbury, 323,772; Marylebone, 370,957; Greenwich, 105,784; Lambeth, 251,345; and Westminster, 241,611; and the towns of Burnley, 20,828; Bury, 31,262; Chatham, 28,424; Cheltenham, 35,051; Dudley, 37,962; Huddersfield, 30,880; Merthyr Tydfil, 63,080; Rochdale, 29,195; Stroud, 36,535; and Stoke-upon-Trent, 84,027. In Scotland there are no towns containing a population of 10,000 which are not municipal burghs.

One of the subjects most carefully considered in taking the Census of 1851, was that of the *Occupations of the People*. In the previous decennial enumerations, an inquiry of a similar kind was instituted, but with less minuteness. In 1851, to use the words of the Registrar-General, "It was considered important to extend the inquiry, so as to show, as nearly as was practicable, the number of men, women, and children in every trade and profession;" and it was further held to be desirable, notwithstanding the great additional labour entailed in abstracting and tabulating the results, "not only to take out the number of persons of each sex in each occupation, but the numbers at each quinquennial period of age; for without this information the relative salubrity of the professions, and a great variety of important questions, cannot be determined." The results of the inquiries instituted were embodied in a bulky but very able report, published subsequently to the General Report; and in it the subject is examined as a whole, and in detail from various points of view, and numerous elaborate tables present the results as digested after a vast amount of labour and consideration.

In looking at the tables with regard to the more general results, there are many interesting particulars which become developed. Thus: one-half of the total population is 10,479,738. Now this is almost exactly identical with the number (10,418,989) of those set down under some domestic appellation, as wife, widow, daughter, grand-daughter, sister, niece, son, grandson, brother, nephew, child under tuition at home, child under tuition at school; that is, persons to whom no occupation whatever is attributed, but who are regarded as dependent on the head of the family for support. Regarded in this light, therefore, just one-half of the population have nothing, and do nothing to earn a living; they are the home-members of a family; they may assist in domestic labours, but they do not work at money-getting employments. There are then left half the population, who either possess wealth already accumulated, or exercise their hands and heads in the acquisition of wealth; of this half, one moiety can, with a near approach to correctness, be divided into five equal parts, thus:—

About 1,000,000 domestic servants.
„ 1,000,000 employed in preparing the materials for dress.
„ 1,000,000 employed in making dress.
„ 1,000,000 ordinary agricultural labourers (males.)
„ 1,000,000 other persons, male and female, living by farm and field operations.

Most of these numbers are slightly over the million. If we suppose the two millions of farmers, graziers, gardeners, and in-door and out-door farm-servants of every kind, to be all employed in raising food (and this is not such a wide departure from the truth as to vitiate such general results as we have now in view), it brings us to this conclusion: of the total population, about 21,000,000, there are:—

Of family dependents, having no definite occupation . . . . . = about one-half.
Of persons supplying dress, food, or domestic service . . . . . = about one-quarter.
Of persons employed in all other occupations . . . . . = about one-quarter.

In preparing their vast tables of the distribution of occupations in the respective divisions, counties, districts, and towns, the commissioners had to determine how many different occupations should be given in each table. In the whole there were 1057 occupations for males returned. These, for the purpose of tabulation, would have been utterly unmanageable; they therefore, after much consideration, reduced them into 17 groups, or classes of persons having definite occupations, and these they again divided into 91 sub-classes. The list of their principal classes will give some notion of their mode of procedure:—1. Persons engaged in the general or local government of the country. 2. Persons engaged in the defence of the country. 3. Persons in the learned professions. 4. Persons engaged in literature, fine arts, and science. 5. Persons returned only as children, or relations and scholars. 6. Persons engaged in entertaining, clothing, and performing personal offices for man. 7. Persons who buy or sell, keep, let, or lend money, houses, or goods of various kinds. 8. Persons engaged in the conveyance of men, animals, goods, and messages. 9. Persons possessing or working the land, and engaged in growing grain, fruits, grasses, animals, and other products. 10. Persons engaged about animals. 11. Persons engaged in art and mechanical productions. 12. Persons working and dealing in animal substances. 13. Persons working and dealing in vegetable substances. 14. Persons working and dealing in minerals. 15. Labourers and others—branch of labour undefined. 16. Persons of rank or property, not returned under an office or occupation. 17. Persons supported by the community, and of no specified occupation.

The classification was, in a measure, arbitrary and unsatisfactory, as yoking together occupations of a very dissimilar kind; but it was convenient, and, with some modifications, will probably be adhered to in future enumerations.

The 91 sub-classes were subdivided into the 1057 occupations or employments for males. A separate classification for females amounts to 746 employments. These are, of course, in some cases identical with those of men; in other cases, nearly alike but differently named; while in others they are wholly distinct and feminine in their character.

Taking the 1057 occupations for males, just as they stand in the classified tables, the highest numbers are the following, comprising those exceeding 40,000 persons in each employment:—

Agricultural labourers	1,006,728
Labourers (undefined)	367,472
Farmers	275,676

Shoemakers	243,052
Farm-servants, indoor	235,943
Cotton-spinners and weavers	222,612
Coal miners	216,366
Carpenters	182,546
Tailors	135,028
Blacksmiths	112,184
Masons	101,391
Porters and messengers	97,642
Merchant seamen	89,206
Woollen spinners and weavers	86,649
Domestic servants	79,615
Gardeners	78,462
Grocers	68,242
Butchers	65,912
Plumbers, painters, and glaziers	62,421
Carmen and drivers	56,252
Bakers	55,663
Worsted spinners and weavers	51,863
Engineers and machinists	48,050
Silk spinners and weavers	45,169
Clerks (commercial)	43,741

Among females of twenty years of age and upwards, the highest numbers placed opposite definite occupations are the following:—

Domestic servants (general)	401,950
Milliners	202,437
Cotton-spinners and weavers	143,212
Washerwomen and manglers	136,582
Farm-servants, in-door	67,538
„ out-door	56,067

These numbers, however, must not be used for any inferential purpose, without taking others belonging to employments collaterally connected with them. Thus, the 401,950 *general* servants do not include about 200,000 others who enter themselves under the more specific designations of housekeeper, housemaid, cook, nurse, and inn servant; the 202,437 milliners are irrespective of 140,000 seamstresses and needlewomen of other kinds; and so in other cases. It must also be borne in mind, in respect both of the male and the female lists, that the highest numbers are attached to designations which are rather degrees of relationship than occupations. For instance, we find—

Wives (not otherwise specified)	2,631,380
Children and relations at home, ditto	4,745,217
Children who attend school, ditto	2,752,737

Here we have at once more than a third of the entire population entered under three headings, excluding everything like a business designation.

As a summary of results relating to occupations generally, without regard to age, sex, or topographical distribution, it may be profitable to give the annexed table, containing the commissioners' own enumeration of the number of persons employed in 108 avocations in Great Britain, comprising all those for or in respect of which the numbers exceed 10,000. Mere domestic relationship, such as "wife," "widow," &c., is not here taken into account; all are "occupations," in the usual meaning of that word—male or female, adult or juvenile.

OCCUPATIONS IN GREAT BRITAIN, AND NUMBER OF PERSONS ENGAGED IN THEM (ARRANGED IN THE ORDER OF THE NUMBERS), IN 1851:—

Occupations.	Persons.	Occupations.	Persons.
Agricultural labourer, farm servant, shepherd	1,460,896	Linen, flax manufacture	98,860
Domestic servant	1,038,791	Seaman (merchant service) on shore or in British ports	89,206
Cotton, calico, manufacture, printing and dyeing	501,465	Grocer	85,913
Labourer (branch undefined)	376,551	Gardener	80,946
Farmer, grazier	306,767	Iron manufacture, moulder, founder	80,032
Boot and shoe maker	274,451	Innkeeper, licensed victualler, beershop-keeper	75,721
Milliner, dressmaker	267,791	Seamstress, shirtmaker	73,068
Coal-miner	219,015	Bricklayer	67,989
Carpenter, joiner	182,696	Butcher, meat-salesman	67,691
Army and navy	*178,773	Hose (stocking) manufacture	65,499
Tailor	152,672	School-master, mistress	65,376
Washerwoman, mangler, laundry-keeper	146,091	Lace manufacture	63,660
Woollen cloth manufacture	137,814	Plumber, painter, glazier	62,808
Silk manufacture	114,570	Baker	62,472
Blacksmith	112,776	Carman, carrier, carter, drayman	56,981
Worsted manufacture	104,061	Charwoman	55,423
Mason, paviour	101,442	Draper (linen and woollen)	49,184
Messenger, porter, errand-boy	101,425		

* This is the Army and Navy of the United Kingdom, exclusive of the Indian Army and Navy.

Occupations.	Persons.	Occupations.	Persons.
Engine and machine maker	48,082	Warehouse-man, -woman	17,861
Commercial clerk	43,760	Saddler, harness maker	17,583
Cabinet-maker, upholsterer	40,897	Hatter, hat manufacture	16,975
Teacher (various), governess	40,575	Coachman (not domestic servant), guard, postboy	16,836
Fisher-man, -woman	38,294	Law clerk	16,626
Boat, barge, -man, -woman	37,683	Coachmaker	16,590
Miller	37,268	Cow-keeper, milk-seller	16,526
Earthenware manufacture	36,512	Ropemaker	15,966
Sawyer	35,443	Druggist	15,643
Railway labourer	34,306	Surgeon, apothecary	15,163
Straw-plait manufacture	32,062	Tin miner	15,050
Brick maker, dealer	31,168	Paper manufacture	14,501
Government civil service	30,963	Coalheaver, coal labourer	14,426
Hawker, pedlar	30,553	Greengrocer, fruiterer	14,320
Wheelwright	30,244	Muslin manufacture	14,098
Glover	29,882	Confectioner	13,865
Shopkeeper (branch undefined)	29,800	Tinman, tinker, tin plate worker	13,770
Horsekeeper, groom (not domestic), jockey	29,408	Staymaker	13,699
Nail manufacture	28,533	Solicitor, attorney, writer to the signet	13,256
Iron miner	28,088	Dyer, scourer, calenderer	12,964
Printer	26,024	Currier	12,920
Nurse (not domestic servant)	25,518	Builder	12,818
Shipwright, shipbuilder	25,201	Farm bailiff	12,805
Stone quarrier	23,489	Hair-dresser, wig-maker	12,173
Lodging-house keeper	23,089	Coal merchant, dealer	12,092
Lead miner	22,530	Glass manufacture	12,005
Copper miner	22,386	Carpet and rug manufacturer	11,457
Straw hat and bonnet maker	21,902	Goldsmith, silversmith	11,242
Cooper	20,245	Brass founder, moulder, manufacturer	11,230
Watch and clock maker	19,159	Maltster	11,150
Brewer	18,620	Bookbinder	10,953
Clergymen of Established Church	18,517	Railway officer, clerk, station master	10,948
Protestant Dissenting minister	9,644	Road labourer	10,923
Dock labourer, dock and harbour service	18,462	Wine and spirit merchant	10,467
Police	18,348	Fishmonger	10,439
Plasterer	17,980	Merchant	10,256
		Ribbon manufacturer	10,074

Leaving these general results, which apply for the most part to the whole of Great Britain, and to the whole circle of occupations, we proceed to notice a few of the results having a somewhat more special character. One of these has relation to the employment of the many by the few, and another relates to farms, farmers, and farm-labourers.

One of the valuable results of the Census of 1851, is the determination, to a certain degree of correctness, of the relative positions of employers and employed; a classification of masters and men in each occupation. Many of the schedules sent by the commissioners were imperfectly filled up; but the general result approximates on the whole pretty nearly to accuracy. We may solve many interesting questions by means of the tables thus produced. For instance, let the question be this: How many occupations are there in which some of the masters employ 350 hands or more? They are the following:—shoemakers, glove-makers, stocking-weavers, engine and machine makers, builders, carpenters, manufacturing chemists, tanners, woollen manufacturers, worsted manufacturers, flannel manufacturers, woollen dyers, silk manufacturers, ribbon manufacturers, fancy goods manufacturers, shawl manufacturers, brewers, cotton manufacturers, lace manufacturers, paper-makers, stationers, coal-merchants, coal-miners, contractors, earthenware manufacturers, glass manufacturers, silversmiths, tin-plate workers, white metal workers, button-makers, iron manufacturers. Let the question be,—Which occupations contain the greatest number of firms employing 350 or more persons each? We find, in answer, 113 cotton manufacturers, 21 woollen manufacturers, 13 silk manufacturers, 12 worsted manufacturers, 14 engine and machine makers, 7 earthenware manufacturers, 5 iron manufacturers, 5 builders. Let the question be,—How many masters employ bodies of men not less than 100 in number? The answer, slightly classified, comes out as follows:—

390	masters employ from	100	to 150	men each
236	„	„	150 to 200	„
135	„	„	200 to 250	„
88	„	„	250 to 300	„
65	„	„	300 to 350	„
228	„	„	350 and upwards	„

1142 masters each employ 100 men or upwards.

These and similar questions are in the report followed out in great detail, and with reference to the great centres of the particular branches of national industry, but our space does not permit us to continue the subject further.

In respect of agricultural pursuits, the commissioners sought to obtain a return of the number of farms, the size of the farms, and the

number of persons engaged in them. The following is a convenient general outline of the result :—

Size of Farms.	Number of Farms.			
Acres.	Great Britain.	England and Wales.	Scotland.	Islands in British Seas.
Total . .	283,378	223,271	56,150	3,957
Under 100	190,573	142,358	44,469	3,746
100	52,912	45,752	7,009	151
200	20,603	18,401	2,166	36
300	9,031	8,061	961	9
400	4,063	3,585	471	7
500	2,248	1,971	272	5
600	2,816	2,372	442	2
1000 and upwards.	1,132	771	360	1

Besides the above, there were 2558 farms of which the sizes were not stated in the returns, making 285,936 farms or farm-holdings altogether. It is found that large farms prevail most in the north, and in Norfolk and Suffolk. The average size of all the farms is 102 acres; and, taken in the aggregate, they occupy just about one-half of the territory of Great Britain. Two-thirds of the farms are less than 100 acres each in extent. About 9000 small farmers seem to have no labourers except the members of their own families; about 170 farmers employ more than 60 labourers each; while all the rest have in their service a number varying from 1 to 60.

Professional avocations, as distinguished from trading and manufacturing, may be brought together in the following form :—

	Males.	Females.
Persons engaged in the general or local government of the country :—		
Civil Service	38,849	1,487
Local service	29,851	1,113
East India (in England)	3,774	—
Persons engaged in the defence of the country :—		
*Army, with pensioners, &c., at home.	70,718	—
Navy	25,796	—
Persons engaged in religious duties :—		
Clergymen of national churches	18,587	—
Other ministers (and not returned under any secular calling)	9,614	—
Subordinate officers	6,371	879
Persons engaged in law and justice :—		
Judges	85	—
Barristers, advocates, &c.	3,111	—
Solicitors, attorneys, &c.	13,582	—
Law students	1,659	—
Law clerks, &c.	19,149	—
Persons engaged in the medical profession :—		
Physicians	2,328	—
Surgeons and apothecaries	15,163	—
Chemists and druggists	15,333	—
Students and assistants	3,655	—
Miscellaneous	2,012	751
Persons engaged in literature, the fine arts, and sciences :—		
Authors, editors, &c.	2,949	118
Artists, architects, &c.	8,609	536
Scientific persons	496	22
Professors and teachers	34,150	71,957
Actors and actresses, theatre servants	1,485	785
Musicians and vocalists	6,081	798
Engravers	5,507	77
Carvers and modellers	2,293	75
Pattern designers	2,161	43
Draughtsmen	597	—
Medallists and die-sinkers	489	14

Supposing that the above may be fairly reckoned as professional employments, it appears that, on Census-day in 1851, there were 344,464 males and 78,467 females thus occupied. These comprise 1 in 30 of all the males, 1 in 140 of all the females, and 1 in 50 of the whole population. If we omit the sailors and soldiers from the list of professional men, the ratio will become about 1 in 60.

Some of the most curious, probably some of the most valuable, tables in the Census Reports are those which establish a comparison between different parts of the country. Large generalisations may be made from the tables which relate to the whole of Great Britain; but for comparison and analogy, the sectional tables have a peculiar value of their own. In reference to a particular department of occupation, or a particular social relation, we may wish to know how far Wales differs from England, and Scotland from both; how far the 10 divisions into which England is separated differ one from another in characteristics;

* But the total of the Queen's forces, at home and abroad, naval and military, effectives and non-effectives, was 262,570.

in what way the 40 English counties, 12 Welsh counties, and 32 Scotch counties exhibit peculiar characteristics; by what peculiarities the 623 registration districts or poor-law unions of England and Wales are distinguished; and so forth. The voluminous census tables afford a store of information on all these local details.

Of course, when different districts or portions of the kingdom are treated separately, the metropolis comes in for the first notice; the following, then, is a rough outline of employments generally in the metropolis. Confining our attention, at present, to males, and to males only of 20 years and upwards, we find the following facts: That out of the 5,458,815 males of 20 years and upwards in Great Britain, 632,545 live in the metropolis; that the London shoemakers number 26,639, and the London tailors 20,257; that there are no fewer than 25,708 domestic and inn servants; that the commercial establishments are so numerous and extensive as to employ 15,135 clerks and travellers; that the coachmen, drivers, carriers, waggoners, draymen, and others who drive vehicles through the London streets, number more than 17,000, besides 14,000 messengers and porters, in addition to railway, canal, and river servants; that there are, for house-work, 21,174 carpenters, 13,817 painters and glaziers, and 16,038 bricklayers and plasterers; that among those who supply us with food and drink, are 9841 bakers, 7428 butchers, 6843 publicans, 6475 grocers, 3372 milk-sellers, 3325 greengrocers, 2238 fishmongers, and 2156 cheesemongers; that the leather trades, chiefly in Bermondsey, employ 5391; that there are 13,206 persons employed in printing, binding, and selling books; that the wood-furniture makers and sellers number 13,574; and that there are more than 40,000 labourers whose branch of labour is undefined, but who must be distinguished from skilled artisans.

Let us next—still confining our attention to the metropolis—glance at the female occupations in a similar way. Among the 5,998,384 females, aged 20 years and upwards, living in Great Britain, 762,418 are in London. Of this number, 316,517 designate themselves simply as wives, and 26,627 simply as widows, and about 40,000 as daughters, without any other alleged employment. But of those who appear to earn their living by the labour of their own hands or brains, there are no fewer than 118,855 domestic servants of various kinds, 73,620 needlewomen of various kinds, and 45,754 charwomen, washerwomen, and manglers. These, with 25,652 annuitants, and gentlewomen of independent means, comprise all the large items among the female adult population of the metropolis; all the other items are, individually, very small. These facts are not without their instruction; for they show how limited is the range of female employments in London. They show too, that, after deducting those who are dependent on relations for support, and those of independent means, there were 330,000 adult females in London in 1851 dependent on their own exertions for their daily bread; and they show also how large must be the number of families in comfortable circumstances in London, to give employment to nearly 120,000 female servants and 45,000 laundry- and charwomen.

But now let us compare one of the manufacturing counties of the North with London, to ascertain how far a different principle seems to determine the distribution of occupations. We take the cotton-spinning county of Lancashire. Here we have 539,075 males of 20 years of age or upwards, against 632,545 in the metropolis; that is, in the ratio of about 85 to 100. Different indeed, however, is the ratio in regard to employments. We have seen that the metropolis contains about 26,000 male adult servants, 31,000 drivers and porters, 27,000 shoemakers, 21,000 carpenters, 20,000 tailors, 16,000 bricklayers, 15,000 clerks, 14,000 painters; whereas, in Lancashire, these eight occupations exhibit the numbers 4708, 9127, 15,443, 12,146, 11,346, 7658, 7643, 6336—all far below the ratio in respect to total inhabitants. In London there are 35,000 persons in the public service, receiving emoluments from the community at large; whereas in Lancashire there are only 11,000. In London there are 34,000 professional men, engaged in divinity, law, physic, science, and fine arts; in Lancashire the number is 11,000. In London there are 14,000 persons employed in writing, printing, binding, and selling books and periodicals; in Lancashire there are 2000. All these numbers, it is evident at a glance, differ widely; London having far more than its ratio of 100 to 85 in each of these employments. But let us turn the tables, and see what are the employments wherein Lancashire takes precedence of the metropolis. Of course, in a county, farmers, graziers, shepherds, gardeners, agricultural labourers, and so forth, must be relatively more numerous than in a city; and thus we need not be surprised to find 56,000 of these in Lancashire, against 14,000 in the metropolis. And, considering the wonderful shipping activity of Liverpool, and the numerous canals which traverse Lancashire in every direction, we may be prepared to expect that this county and the metropolis are not far from equal in the numbers of persons connected with ships, boats, and barges in various capacities; in the metropolis this number is about 21,000, in Lancashire 18,000—very nearly, indeed, in the ratio of 100 to 85. But it is in textile manufactures, and in minerals, that Lancashire most decidedly takes the lead before London. In Lancashire there are 104,000 persons (out of about 540,000) engaged in various departments of the cotton manufacture, against a few hundreds in London; 7000 in woollen manufactures, against a few hundreds; 21,000 coal miners and labourers, against 5000; 3000 quarrymen, against 500.

Here it must be borne in mind, that the numbers in the preceding

paragraph are of males only, and males too who have reached their 20th year or upwards. A few parallel entries will suffice, relating to certain occupations for adult females: of domestic servants and nurses there are 125,000 in London, and 55,000 in Lancashire; of silk-workers, 8000 in London, and 12,000 in Lancashire; of cotton-workers, 1000 in London, and 90,000 in Lancashire. Here we find that one-sixth of all the adult females in London are domestic servants or nurses, and that one-sixth of all the adult females in Lancashire are engaged in the cotton manufacture.

There are also striking differences in respect to juvenile labour:—The metropolis contains 474,013 males, and 493,260 females, under 20 years of age; the numbers in Lancashire are 469,749 and 474,735 respectively. Now in the metropolis, after deducting 770,000 young persons who are entered only in their domestic or family relations, without connection with any particular employments, there remain about 200,000 who are considered to have some occupation or other; whereas in Lancashire there are 270,000 having employment; and out of this number about 120,000 are employed in the cotton manufacture alone—that is, 120,000 young persons. In the metropolis, on the other hand, young seamstresses and young domestic servants chiefly fill the list.

We turn now to other phases of metropolitan employment. Of the whole 2,362,236 inhabitants, there are, in round numbers, 630,000 men, 760,000 women, and 970,000 persons of both sexes under 20 years of age. Of this latter number, nearly 300,000 are under five years of age, and therefore almost equally removed from schooling and occupation. In order to show, then, how far male employments are to be met with in London for young persons, we give the following table in relation to a few occupations:—

	Under 20.	20 and upwards.
Law clerks	1,530	5,401
Teachers	457	4,285
Messengers and porters	19,743	13,471
Printers, &c.	3,213	13,206
Silk manufacturers	1,435	8,388
Cabinet-makers	2,361	13,963
Gold and silver work	1,145	6,419
Brass work	1,066	5,358
Iron work	2,170	13,604
Building trades	6,981	59,451

It is probable that the greater part of the above young persons are apprentices, although the returns do not specify this fact in words. The 19,743 young messengers and porters are evidently the "errand boys," rather a formidable body in London. Taking female occupations instead of male, and noticing the difference of age in a similar manner, we find the following:—

	Under 20.	20 and upwards.
Teachers	1,314	11,185
Servants	46,524	138,262
Needlewomen	20,288	124,165
Silk-workers	2,373	8,847
Paper-workers	625	1,132

If we were to name the three most characteristic kinds of occupations in London for males under 20 years of age, therefore, they would be apprentices to mechanical trades, errand boys, and junior clerks; and for females under 20 years of age, they would be servants, needlewomen, and teachers.

The Report enables us to follow the subject of the industrial occupations of the metropolis in very minute detail, the distributions of trades in particular localities, &c., but it will be more satisfactory perhaps to occupy our remaining space with a rapid comparison of the occupations of some of the more remarkable districts of the country, or such as illustrate broad general principles of industrial distribution. Take a few of the principal manufacturing towns in succession.

Birmingham.—Here the males under 20 years of age (or, as we shall for brevity call them, boys) are 52,640, and above 20 years (men) 61,276; the females under 20 (girls) are 53,380, and above that age (women) 65,545. The leading trades are connected with working in metal. In round numbers 2000 men are employed in making guns, 1800 making machines and tools, 2400 working in gold and silver, 3000 are brass founders, 1400 button makers, 1200 white and black smiths, 1400 iron manufacturers, 400 nail makers. Of the males under 20, no less than 7000 are employed in the few metal trades above enumerated. In Birmingham, 1300 young females and 1600 adult females are employed in making buttons, 700 and 1100 in miscellaneous works in mixed metal, 800 and 1200 in miscellaneous iron and steel works.

Manchester and Salford.—In these cotton towns are—

Males.	Females.	Total.	
86,551	+ 89,043	= 175,594	under 20 years.
104,906	+ 120,821	= 225,727	20 and upwards.
191,457	+ 209,864	= 401,321	total population.

Here one single entry, cotton manufacture, comprises enormous numbers—13,257 men, 5692 boys, 14,503 women, 9051 girls, making a total of 42,503, in which the females exceed the males by 23,554

against 18,949. Putting the whole of the textile manufactures together—relating to cotton, flax, silk, and wool, they appear to employ about 25,000 men, 8000 boys, 20,000 women, and 12,000 girls, exhibiting the remarkably near equality of 33,000 males to 32,000 females—more than 1 in 7 of the entire population of Manchester and Salford employed in making the textile materials for dress, besides 12,000 tailors and seamstresses employed in making up textile materials into dress.

Nottingham.—Here we enter a bobbin-net and cotton stocking town:—

Males.	Females.	Total.	
11,782	+ 12,746	= 24,528	under 20 years.
14,805	+ 18,074	= 32,879	20 and upwards.
26,587	+ 30,820	= 57,407	total population.

Of these we find—stocking-makers, 2469 men, 412 boys, 1588 women, 474 girls, making nearly 5000 persons, or more than one-twelfth of the whole of the inhabitants, employed in this one branch alone. The bobbin-net manufacture employs 1376 men, 517 boys, 3277 women, 1902 girls, exhibiting a still more striking total of more than 7000 persons. Of the aggregate 12,000, more than 7000 are females. It is worthy of notice that the hose and lace-workers bear a larger ratio to the population of Nottingham, than the whole of the textile workers bear to the population of Manchester.

Merthyr Tydvil.—We quit hosiery and lace, to turn to iron and coal:—

Males.	Females.	Total.	
14,357	+ 13,628	= 27,985	under 20 years.
19,650	+ 15,443	= 35,093	20 and upwards.
34,007	+ 29,071	= 63,078	total population.

Under the heading "coal miners," are 1671 boys and 4302 men; and among iron workers 2038 boys and 6915 men; making a total of about 15,000 workers in these two minerals alone; these, with 700 or 800 females similarly employed, comprise a quarter of the entire population. Considerably more than half the adult male population of Merthyr Tydvil are workers in iron and coal, employed chiefly in the four great establishments of Dowlais, Cyfarthfa, Pen-y-darren, and Plymouth works.

Bradford.—This busy Yorkshire town introduces us to a wholly different class of manufactures. The parliamentary borough is somewhat extensive, and includes some of the neighbouring villages, comprising a population of—

Males.	Females.	Total.	
22,934	+ 24,399 =	47,333	under 20 years.
27,032	+ 29,413 =	56,445	20 and upwards.
49,966	+ 53,812 =	103,778	total population.

Of these are entered, under worsted and stuff manufacture, 5381 boys, 10,759 men, 7936 girls, and 8780 women—a powerful body of about 33,000 persons (nearly a third of the whole population) employed in worsted and stuff manufactures alone. The woollen cloth, the silk, and the cotton manufactures, occupy perhaps 1000 altogether, showing how insignificant they are at Bradford.

Leeds.—The borough contains—

Males.	Females.	Total.	
38,468	+ 38,987 =	77,455	under 20 years.
45,246	+ 49,569 =	94,815	20 and upwards.
83,714	+ 88,556 =	172,270	total population.

We devote a short paragraph to Leeds, for the purpose of showing how remarkable a contrast may be presented in the industry of two towns situated only about ten miles apart. Bradford and Leeds both work up wool largely; but Bradford prepares it for stuff or worsted fabrics, while Leeds prepares it for woollen cloth. Leeds has 2920 boys, 7640 men, 1710 girls, and 2624 women employed in making woollen cloth: while the stuff and worsted manufactures barely employ 1000. Leeds, however, is a large manufacturing town in other respects; for it employs about 9000 persons in the flax manufacture, and 3000 in making engines and machines. Relatively to the population, Huddersfield is perhaps more peculiarly associated than Leeds with the woollen cloth manufacture.

Macclesfield.—This borough, the centre of the silk trade, contains—

Males.	Females.	Total.	
8,299	+ 8,735 =	17,034	under 20 years.
10,242	+ 11,772 =	22,014	20 and upwards.
18,541	+ 20,507 =	39,048	total population.

Of these, 2462 boys, 4772 men, 2979 girls, and 4339 women are employed in the silk manufacture; making an aggregate of about 14,500 persons, considerably more than one-third of the entire population. The males and females are employed in almost exactly equal numbers, 7234 to 7318.

Sheffield.—In this cutlery borough there are :—

Males.		Females.		Total.	
31,108	+	31,112	=	62,220	under 20 years.
36,392	+	36,698	=	73,090	20 and upwards.
67,500	+	67,810	=	135,310	total population.

The works in gold, silver, steel, iron, and mixed metals employ about 20,000 men and boys at Sheffield. Females are very little employed in the metal trades, thereby presenting a striking contrast to the arrangements at Birmingham. No fewer than 2461 boys and 7044 men are employed in making and grinding cutlery and files alone.

Glasgow.—There are two or three Scotch towns which present remarkable characteristics. Glasgow has—

Males.		Females.		Total.	
71,474	+	73,593	=	145,067	under 20 years.
83,455	+	100,574	=	184,029	20 and upwards.
154,929	+	174,167	=	329,096	total population.

This busy city is worthy of note for the degree in which it combines cotton working and iron working, two departments of industry which certainly do not seem to have any very necessary bond of connexion. There are 3449 boys, 11,371 men, 9692 girls, and 16,442 women—about 15,000 males and 26,000 females—employed in various branches of the cotton manufacture. Of all the females in Glasgow, in every age and condition, one in seven is employed in this manufacture. In the metal trades, there are 2600 machine and tool makers, 4800 miners and manufacturers, and 5400 other workers in metal—almost wholly males.

Dundee.—This is the great centre of the flax and linen manufacture of Scotland. Dundee contains—

Males.		Females.		Total.	
17,444	+	17,999	=	35,443	under 20 years.
18,420	+	25,068	=	43,488	20 and upwards.
35,864	+	43,067	=	78,931	total population.

Of these numbers there are 2713 boys, 6161 men, 4300 girls, and 6568 women, employed in flax and linen manufactures, being almost exactly one-fourth of the whole population—a ratio which certainly appears surprisingly large. Aberdeen is also engaged in these trades, but in a very much smaller ratio than Dundee.

These few examples would perhaps suffice to illustrate the distribution of particular branches of manufacture in the principal towns; but, adopting a still more compressed form we will give a few additional instances in the following way :—

At *Portsmouth*, out of about 35,000 men and boys in the borough, about 9000 are in the public service, and receive pay from the community; while there are about 2000 privately employed as seamen or as shipwrights. At *Leicester*, out of 60,000 persons, nearly 9000 are employed in making worsted stockings and similar articles. At *Northampton*, out of 13,000 men and boys, more than 4000 are employed in making boots and shoes, the staple industry of the place; and at *Stafford* the men and boys similarly employed are in the ratio of one to four of the whole male population. At *Worcester*, out of 15,080 women and girls, 2133 are employed in making gloves. Of the 25,705 men and boys in *Wolverhampton*, about 7500 are employed upon metals or upon coal; no less than 1400 make locks alone. In *Dudley* the ratio is about as high, about 6000 out of 19,093. *Coventry* is remarkable for two trades, about as diverse as any two can be, ribbon-making and watch-making: out of a population of 36,612, nearly 10,000 persons (of whom 6500 persons are females) are employed upon silks and ribbons; while 1700 men and boys are making watches. At *Stockport*, 17,000 persons are employed in cotton manufactures, out of a total population of 53,835—nearly one in three; at *Blackburn*, 16,000 out of 46,536—more than one in three; at *Bolton*, 14,500 out of 61,171; *Oldham*, 20,000 out of 72,357; at *Preston*, 18,000 out of 69,542. Thus, in these five cotton spinning and weaving towns, containing an aggregate of about 300,000 inhabitants, about 34,000 males and 42,000 females—considerably more than one-fourth of all the inhabitants—are engaged in this manufacture. Looking at the distribution of workers in reference to age, we find that there are about 33,000 children and young persons under 20, and 43,000 adults of 20 and upwards. In *Paisley*, out of about 31,000 inhabitants, nearly 9000 are employed in various kinds of textile manufacture, of which the principal is shawls.

Hitherto, in the above paragraphs, we have spoken of distinct towns, each with defined limits and defined number of inhabitants. But a few remarkable manufactures are centred rather in districts than in large towns.

In *Staffordshire*, the registration county contains 320,903 males and 309,641 females. Now, it is plain, on a little examination, that the main departments of industry whereby these are supported have relation to mineral manufactures; and it is further observable, on comparing the several districts, that while the southern exhibit the metallic and colliery operations, the northern are associated with earthenware manufactures. In short, we have the Wolverhampton region of the south, and the pottery region of the north. There are 27,000 males and 1000 females engaged in various departments of the

coal trade; 45,000 males and 7000 females in metallic manufactures; 16,000 males and 9000 females in pottery and earthenware manufactures. It is worthy of note, that in the two districts of Stoke-upon-Trent and Wolstanton, containing the pottery towns of Stoke, Hanley, Lane End, Delph, Etruria, Shelton, Burslem, &c., out of a population of 51,000 adult males and females, more than 13,000 are engaged in the earthenware manufacture. It would perhaps scarcely be expected that, in South Staffordshire, 5000 women are engaged in nail-making.

Bedfordshire, containing 62,539 males and 67,266 females, is not a county likely to contain large manufacturing establishments of any kind; but there are, nevertheless, two or three entries in the tables which deserve attention. There are, we find, 2300 males and more than 10,000 females engaged in the straw-plait manufacture; together with nearly 6000 females occupied in hand-lace making. One-fourth of all the females in the county, of all ages and conditions, are employed in one or other of these two occupations. In *Buckinghamshire*, containing 70,928 males and 72,727 females, the straw-plait trade is smaller, employing only about 3000 females; but the lace-trade is about as extensive as in Bedfordshire, employing nearly 11,000 females. In *Hertfordshire* we almost entirely lose the lace-trade; but the straw-plait employs about 9000 females out of 87,497. In *Cambridgeshire* there is a little done in these two trades, but only a little; and in *Huntingdonshire* there are about 1000 females out of 30,295 engaged in the lace-trade. In these two departments of cottage industry, the females employed are of all ages from 5 to 90, chiefly between 10 and 20.

Worcestershire, for some reason which it is difficult to explain, is the centre of the needle manufacture. At Redditch, in this county, nearly all the inhabitants are supported, directly or indirectly, by this manufacture; although the steel for making the needles, and all the coal for heating the steam-engines, must be brought from other quarters.

Cornwall is rich in metals, but has no coals. It has 172,193 males in the (registration) county. Among these are 3000 seamen and 2600 fishermen; but under mineral working, we find about 16,000 copper-miners, more than 10,000 tin-miners, 2500 lead-miners, and about 6000 employed in other ways on metals and minerals; none, however, in coals. There are also above 6000 females engaged at the "above-ground" works of the copper- and tin-mines.

Let us contrast this with a county containing much coal, but little metal. *Durham* (registration) county contains 207,088 males and 204,591 females,—a departure from the general rule, for here we find more males than females. Now, here are 10,000 men and boys engaged in sea and river navigation; a very large number out of such a population, and evidently due principally to the navigation of colliery vessels. The number of 4500 ship and boat builders is also large, and points to the busy trade of Sunderland. But a much larger item is that of 29,000 men and boys employed in coal-mining and working, about one-seventh of the male population. In *Northumberland*, as might be expected, a somewhat parallel state of things presents itself. There are here 149,515 males; and of these, about 6000 are engaged in navigating ships and boats, 1400 in building ships and boats, and 11,000 coal-miners; the parallelism, it will be observed, is in the nature of the prevalent occupation, and not in their extent, for Durham greatly takes the lead in this respect.

There are two counties in the western part of the kingdom which we may similarly notice, in respect partly to the iron manufacture, but still more decidedly to coal-mining. These are Monmouthshire and Glamorganshire. *Monmouthshire* contains 92,301 males and 82,849 females—another example, in a mining county, of the males outnumbering the females. The iron trades occupy 12,000 males, and the coal trade also 12,000—in round numbers: together more than one-fourth of the entire male population. Females are not much employed in these trades in this county. *Glamorganshire*, containing the remarkable towns of Merthyr and Aberdare and their vicinity, has a population of 125,087 males and 115,000 females. Of these males, no less a number than 15,500 are engaged in the coal trade, and 14,000 in the iron trades. In another Welsh county, *Caermarthen*, copper manufactures are, in respect to the population, if not as remarkable as iron manufactures in Glamorganshire, at least worthy of note as the staple industry of portions of the country. The explanation of this is, that nearly all the copper ores of Cornwall and Devon are sold on the spot to copper-smelters, who have their works at Swansea or Neath, or some other town in Caermarthenshire. But besides the copper workers there are, among the 125,087 males in this county, 14,000 workers in iron, and 15,000 coal-miners.

Such are a few of the striking results obtained by the Census of 1851, relating to the occupations of the people. The entire Report is, however, worthy of the careful study of every person who desires to know something more of the condition of the people, in this hard-working country, than can be derived from vague generalisations and partial inquiries.

Another subject on which it was sought to arrive at some definite results, and on which a separate Report was published, was that of *Religious Worship*. In the Census of 1851, for the first time, the attempt was made to obtain a return of the number of members in the various religious bodies in England and Scotland; but as, for reasons already mentioned, the answers to the questions proposed were not compulsory, but depended on the willingness of the respondent, the

returns are necessarily imperfect. However, in England, returns were sent from 14,077 churches belonging to the Church of England, and from 20,390 places of worship belonging to other religious bodies. The forms issued required information as to the religious denomination of the body; as to the number of places of worship, the number of sittings contained in them; the number of attendants at the morning, afternoon, and evening services on March 30, 1851; with the number of places of worship actually open on that day, and the number of available sittings. The result gave the following thirty-six denominations:—

1. Church of England and Ireland.
2. Church of Scotland,
3. United Presbyterian Synod,
4. Presbyterian Church in England — Scottish Presbyterians.
5. Independents, or Congregationalists.
6. General
7. Particular
8. Seventh Day
9. Scotch — Baptists.
10. New Connexion General
11. Society of Friends.
12. Unitarians.
13. Moravians, or United Brethren.
14. Original Connexion
15. New Connexion
16. Primitive Methodists
17. Bible Christians
18. Wesleyan Association
19. Independent Methodists
20. Wesleyan Reformers — Wesleyan Methodists.
21. Welsh Calvinistic Methodists
22. Countess of Huntingdon's Connexion — Calvinistic Methodists.
23. Sandemanians, or Glassites.
24. New Church.
25. Brethren.
26. Lutherans.
27. German Protestant Reformers.
28. Reformed Church of the Netherlands.
29. French Protestants.
30. Roman Catholics.
31. Greek Church.
32. German Catholics.
33. Italian Reformers.
34. Catholic and Apostolic Church.
35. Latter-day Saints, or Mormons.
36. Jews.

Of the total 34,467 places in England making any return, there were 1394 in which the returns were in some respects incomplete. Perfecting these by estimate, it would appear that there were on the whole 4,647,482 morning attendances, 3,184,135 attendances in the afternoon, and 3,064,449 in the evening. The number of sittings available in the morning was 8,498,520, which may be taken as the total provision for the accommodation of worshippers; the smaller number of sittings returned for afternoon and evening arising, no doubt, from service not being performed three times a day in very many cases. Of the gross number of attendances, which amounted to 10,896,066, there were 5,292,551 to the Church of England; 80,510 to the various Presbyterian places of worship; 1,214,059 to those of Independents; 930,190 to Baptist; 22,478 to Quaker; 50,061 to Unitarian; 10,874 to Moravian; 2,417,353 to the various branches of Wesleyanism; 308,754 to the Calvinistic; 756, Sandemanian; 10,352, New Church; 17,592 Brethren; and 104,675, of isolated congregations. Of the Lutherans, French and German Protestants, there were 2073 attendances; of Roman Catholics, 383,630; of German Catholics, Italian Reformers, and the Apostolic Church, 8262; of Mormons, 35,626; and of Jews, 6030.

In Scotland, on the same day, including an estimate for defective returns, the places of worship were 3395; the number of sittings available, 1,834,805; and the total number of attendants in the morning was 943,951; in the afternoon, 619,863; and in the evening, 188,874. The number of denominations were more numerous than in England, amounting to 40; but the number of the members was very small. The various branches of the Presbyterian church furnished 718,374 of the morning attendants, 542,620 in the afternoon, and 130,468 in the evening. Of the remainder, the Episcopal Church furnished 43,904 total attendants; the Independents, 70,531; the Baptists, 20,958; the Wesleyans, 21,676; the Roman Catholics, 79,823; while the remainder only number from a few hundred each, down to the Jews, who amount to seven.

The above returns, though interesting, it must be distinctly understood, fail to present an accurate view of the state of religious parties in Great Britain. In the first place, there are many minor distinctions of sects which have not been attended to; the estimates for imperfect returns are made on the same principle for all the sects, no allowance is made for variance of manners and customs; for instance, with Presbyterians, most attend the morning and afternoon services, but the evening service is, in many cases, only attended by those who are unable to attend earlier; in the Church of England, the majority of those who attend morning service do not attend again, or if they do, it is in the evening, and in very many country parishes there is only one service a day. Still, though inaccurate in details, the returns cannot fail to show the great features of the chief religious bodies existing among us.

The Census of 1851 also collected some information respecting the state of education; but as there are a variety of other returns on the same subject, the whole will be better treated of under the head of SCHOOLS; the results connected with the inquiries as to the number of the blind, are given under BLIND, CENSUS OF; and dumb persons, their ages, distribution, &c., will be better spoken of in the article DEAF AND DUMB.

With respect to *Ireland*, the circumstance brought out with most startling prominence was the remarkable decrease in the population since the previous Census. Up to that of 1841 each decennial Census of the half-century had shown a steady if not rapid increase of the population. That of 1851 showed that during the past ten years the gain of the previous 20 had been more than undone. In 1821 the total population of Ireland was 6,801,827; in 1851 it was only 6,551,970. And the returns further showed that this decrease was general as compared with 1841; and even as compared with 1821, the only exceptions were some two or three places in Ulster, in each of which, from causes easily understood, there had been a continuous increase of inhabitants during the half century. The large falling off of the population between 1841 and 1851 was mainly owing to the disastrous famine which afflicted Ireland in 1845—47, in consequence of the failure of the potato crop; partly, however, it was due to emigration, which, in its turn, had been greatly stimulated by the failure of the potato, and the consequent agricultural distress. The total emigration from Ireland during the ten years between 1841 and 1851 is estimated to have amounted to 1,289,133, "varying with considerable regularity according to the variations in the state of the labouring classes." For the sake of presenting in one view the increase and decrease of the population of Ireland, we append a table of the number of inhabitants in the four provinces at each decennial Census from 1821 to 1851.

POPULATION.

Provinces.	Area in Acres.	1821	1831	1841	1851
Leinster . . .	4,876,211	1,757,492	1,909,713	1,973,731	1,672,591
Munster	6,064,579	1,935,612	2,227,152	2,396,161	1,857,412
Ulster	5,475,438	1,998,494	2,286,622	2,386,373	2,011,756
Connaught . . .	4,392,043	1,110,229	1,343,914	1,418,859	1,010,211
Total of Ireland	20,808,271	6,801,827	7,767,401	8,175,124	6,551,970

The decrease of population was, as might be expected, most marked in the rural districts. In several of the large towns the census of 1851 showed an actual increase of population, while scarce any showed a falling off, a circumstance arising no doubt from the famishing poor having crowded into them in the hope of obtaining employment or of finding relief. Dublin city, which in 1821 contained 185,881 inhabitants, had 232,726 in 1841, and 258,361 in 1851. Cork, though it showed a decline of nearly 15,000 between 1821 and 1851, showed an increase of above 1000 from 1841. Belfast had more than doubled in population between 1821 and 1851, and between 1841 and 1851 had increased from 75,308 to 100,300. Galway town, which between 1831 and 1841 had fallen in population from 33,120 to 17,275 had increased in 1851 to 23,695.

AREA, HOUSES, AND POPULATION, ON MARCH 31ST, 1851.

	Area in Acres.	HOUSES.			POPULATION.		
		Inhabited.	Uninhabited.	Building.	Persons.	Males.	Females.
Great Britain and Islands in the British Seas .	57,624,377	3,670,192	166,735	29,194	20,959,477	10,223,558	10,735,919
England and Wales . .	37,324,915	3,278,039	153,494	26,571	17,927,609	8,781,225	9,146,384
Scotland	20,047,462	370,308	12,146	2,420	2,888,742	1,375,479	1,513,263
Ireland	20,808,271	1,047,735	65,159	2,113	6,551,970	3,190,507	3,361,463
Islands in the British Seas .	252,000	21,845	1,095	203	143,126	66,854	76,272

TOWN AND COUNTRY POPULATION IN GREAT BRITAIN.

	Number		Population of Towns.	Population of Villages and Detached Dwellings of the Country.	Area in Acres of Towns.	Area in Acres of the Country surrounding the Towns.
	Of Counties.	Of Towns.				
England and Wales . .	52	580	8,990,809	8,936,800	1,724,486	35,600,509
Scotland	32	225	1,497,079	1,391,663	287,134?	19,760,328?
Channel Islands . . .	3	10	68,400	74,726	13,108?	238,892?
Great Britain and Islands in British Seas .	87	815	10,556,288	10,403,189	2,024,648	55,599,729

The two preceding tables will show in the readiest manner the general results of the enumeration of 1851.

We add tables of the population of the counties of Great Britain and Ireland, and the areas in acres, according to the Census of 1851; with the addition, for the sake of comparison, of the enumeration at the first census of Great Britain in 1801, of Ireland in 1821.

Counties.	Acres.	Population.	
		1801.	1851.
ENGLAND.			
Bedfordshire	295,582	63,393	124,478
Berkshire	450,358	110,480	170,065
Buckinghamshire	464,930	108,132	163,723
Cambridgeshire	523,861	89,346	185,405
Cheshire	707,078	192,305	455,725
Cornwall	873,600	192,281	355,558
Cumberland	1,001,273	117,230	195,492
Derbyshire	658,803	161,567	296,084
Devonshire	1,657,180	340,308	567,098
Dorsetshire	632,025	114,452	184,207
Durham	622,476	149,384	390,997
Essex	1,060,549	227,682	369,318
Gloucestershire	805,102	250,723	458,805
Hampshire	1,070,216	219,290	405,370
Herefordshire	534,823	88,436	115,489
Hertfordshire	391,141	97,393	167,298
Huntingdonshire	230,865	37,568	64,183
Kent	1,041,479	308,667	615,766
Lancashire	1,219,221	673,486	2,031,236
Leicestershire	514,164	130,082	230,308
Lincolnshire	1,776,738	208,625	407,222
Middlesex	180,168	818,129	1,886,576
Monmouthshire	368,399	45,568	157,418
Norfolk	1,354,301	273,479	442,714
Northamptonshire	630,358	131,525	212,380
Northumberland	1,249,299	168,078	303,568
Nottinghamshire	526,076	140,350	270,427
Oxfordshire	472,887	111,977	170,439
Rutlandshire	95,805	16,300	22,983
Shropshire	826,055	169,248	229,341
Somersetshire	1,047,220	273,577	443,916
Staffordshire	728,468	242,693	608,716
Suffolk	947,681	214,404	337,215
Surrey	478,792	268,233	683,082
Sussex	934,851	159,471	336 844
Warwickshire	563,946	206,798	475,013
Westmoreland	485,432	40,805	58,287
Wiltshire	865,092	183,820	254,221
Worcestershire	472,165	146,441	276,926
Yorkshire, East Riding . . .	768,419	111,192	220,983
York, City	2,720	16,846	36,303
Yorkshire, North Riding . . .	1,350,121	158,927	215,214
Yorkshire, West Riding . . .	1,708,026	572,168	1,325,495
WALES.			
Anglesey	193,453	33,806	57,327
Brecknockshire	460,158	32,325	61,474
Cardiganshire	443,387	42,956	70,796
Caermarthenshire	606,331	67,317	110,632
Caernarvonshire	370,273	41,521	87,870
Denbighshire	386,052	60,299	92,583
Flintshire	184,905	39,469	68,156
Glamorganshire	547,494	70,879	231,849
Merionethshire	385,291	29,506	38,843
Montgomeryshire	483,323	48,184	67,335
Pembrokeshire	401,691	56,280	94,140
Radnorshire	272,128	19,135	24,716
SCOTLAND.			
Aberdeenshire	1,260,625	121,065	212,032
Argyleshire	2,083,126	81,277	89,298
Ayshire	650,156	84,207	189,858
Banffshire	439,219	37,216	54,171
Berwickshire	309,375	30,206	36,297
Buteshire	109,375	11,791	16,608
Caithness-shire	455,708	22,609	38,709
Clackmannanshire	29,744	10,858	22,951
Dumbartonshire	189,844	20,710	45,103
Dumfriesshire	722,818	54,597	78,123
Edinburghshire	254,300	122,597	259,435
Elginshire	340,000	27,760	38,959
Fifeshire	322,031	93,743	153,546
Forfarshire	568,750	99,053	191,264
Haddingtonshire	185,937	29,986	36,386
Inverness-shire	2,723,501	72,672	96,500
Kincardineshire	252,250	26,349	34,598
Kinross-shire	49,531	6,725	8,924
Kircudbrightshire	610,734	29,211	43,121
Lanarkshire	631,719	147,692	530,169
Linlithgowshire	64,375	17,844	30,135
Nairnshire	137,500	8,322	9,956
Orkney and Shetland	988,873	46,824	62,533
Peeblesshire	226,488	8,735	10,738
Perthshire	1,814,063	125,583	138,660
Renfrewshire	150,000	78,501	161,091
Ross and Cromarty	2,016,375	56,318	82,707
Roxburghshire	460,938	33,721	51,642
Selkirkshire	170,313	5,388	9,809
Stirlingshire	295,875	50,825	86,237
Sutherlandshire	1,207,188	23,117	25,793
Wigtonshire	326,736	22,918	43,389

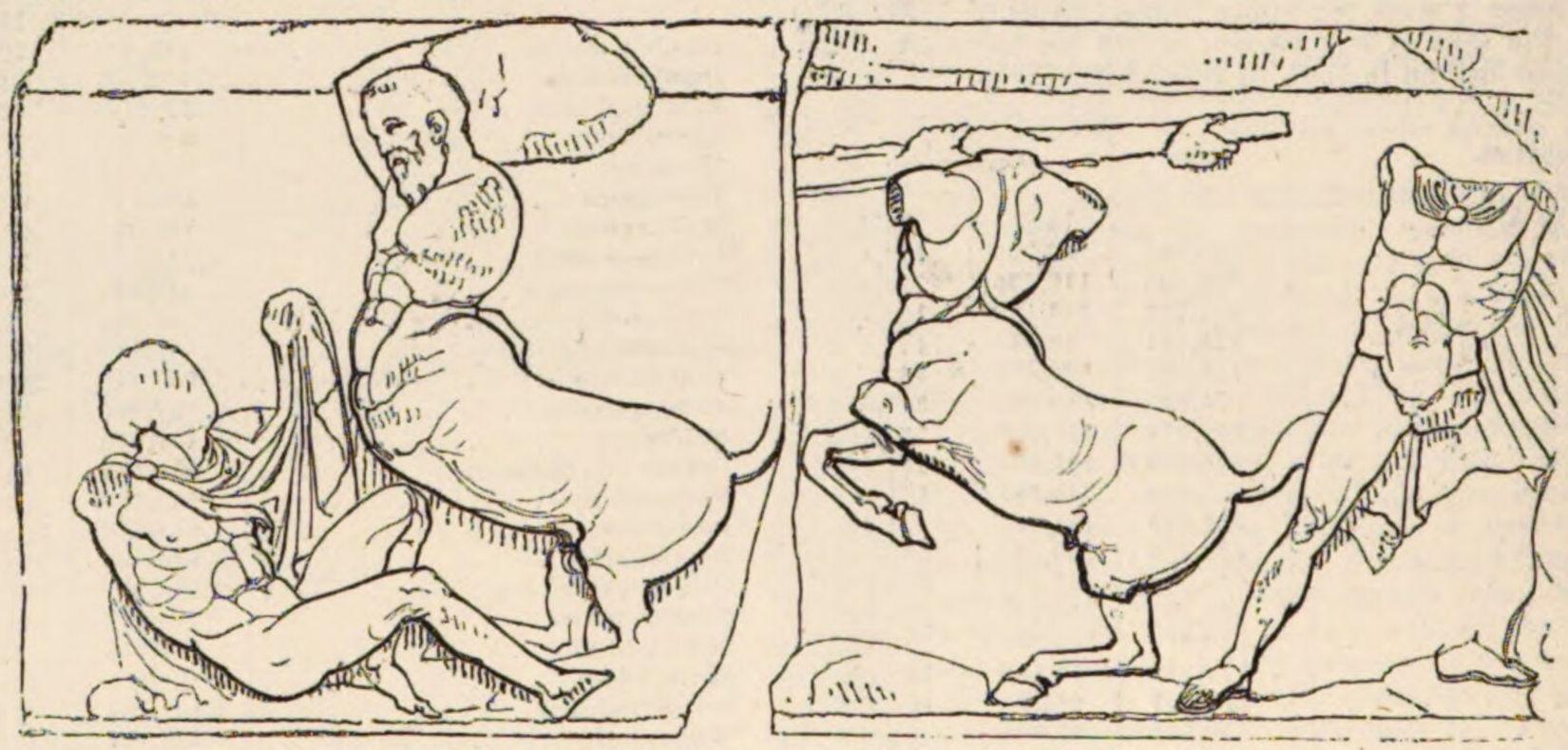
Counties.	Acres.	Population.	
		1821.	1851.
IRELAND.			
Leinster :			
Carlow	221,342	78,952	68,059
Dublin	222,714	150,011	146,731
Dublin city	3,700	185,881	258,361
Kildare	418,436	99,065	95,688
Kilkenny	508,811	158,716	138,773
Kilkenny city	921	23,230	19,973
King's County	493,985	131,088	112,080
Longford	269,409	107,570	82,350
Louth	201,434	101,011	90,812
Drogheda	472	18,118	16,845
Meath	579,899	159,183	140,750
Queen's County	424,854	134,275	111,623
Westmeath	453,468	128,819	111,409
Wexford	576,588	170,806	180,159
Wicklow	500,178	110,767	98,978
Munster :—			
Clare	827,994	208,089	212,428
Cork	1,843,650	629,786	563,326
Cork city	2,683	100,658	85,745
Kerry	1,186,126	216,185	238,239
Limerick	678,224	218,432	208,688
Limerick city	2,618	59,045	53,448
Tipperary	1,061,731	346,896	331,487
Waterford	460,884	127,842	138,754
Waterford city	669	28,679	25,297
Ulster :—			
Antrim	743,881	217,683	251,381
Belfast	1,872	45,177	100,300
Carrickfergus	16,700	8,023	8,520
Armagh	328,076	197,427	196,085
Cavan	477,360	195,076	174,071
Donegal	1,193,443	248,270	255,160
Down	611,919	325,410	320,817
Fermanagh	457,195	130,997	116,007
Londonderry	518,595	193,869	191,868
Monaghan	319,757	174,697	141,813
Tyrone	806,640	261,865	255,734
Connaught :—			
Galway	1,565,726	309,599	298,136
Galway town	628	27,775	23,695
Leitrim	392,363	124,785	111,841
Mayo	1,363,882	293,112	274,612
Roscommon	607,691	208,729	173,417
Sligo	461,753	146,229	128,510
ISLANDS IN THE BRITISH SEAS.			
Isle of Man	180,000		52,387

Countries.	Acres.	Population. 1801.	Population. 1851.
Island of Jersey	40,000		57,020
Island of Guernsey			29,757
Islands adjacent to Guernsey			
Alderney			3,333
Herm	32,000		46
Jethou			3
Le Marchant			
Great and Little Serk			580

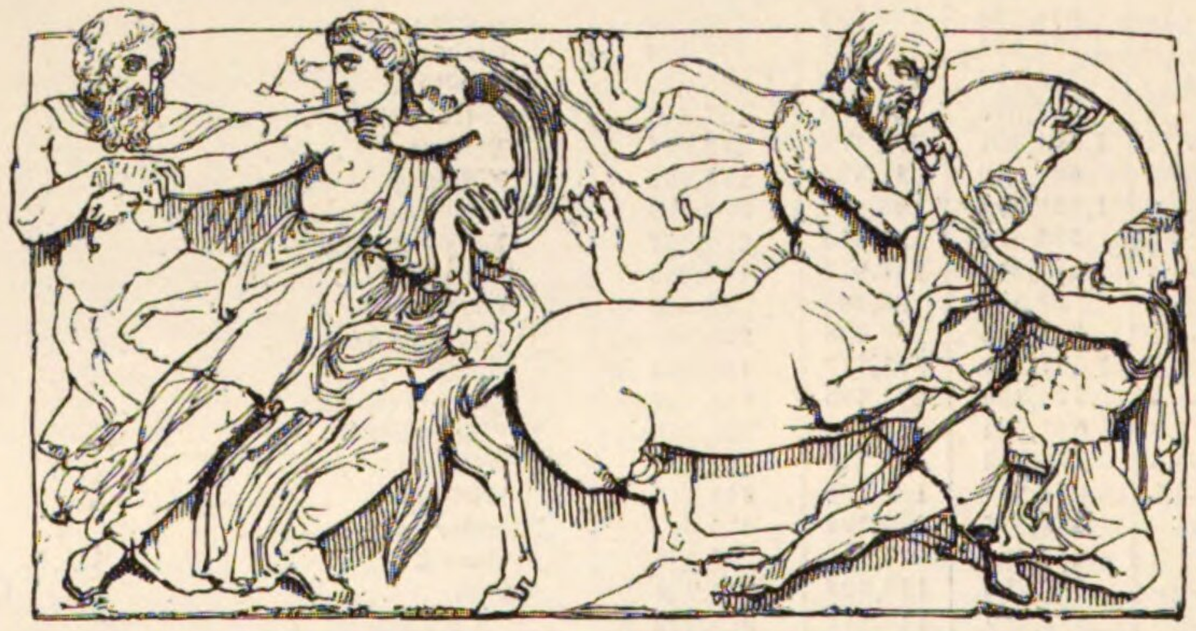
CENTAUR, in mythology, a compound of horse and man, supposed to have sprung from the amour between Ixion and the Cloud, which he mistook for Juno: their name has been thought to point to their origin (κεντ-εῖν, αὔρ-αν); but this explanation can hardly be admitted. It is not improbable that their existence may have been imagined from the first sight of a man on horseback, and as their history makes them neighbours of the Lapithæ, it is probable that they were merely one of those Thessalian tribes among whom the far-famed cavalry of that nation took its rise. They are also called Hippocentaurs. Palæphatus's account of the origin of their name (ἀπὸ τοῦ κεντεῖν τοὺς ταύρους) is a mere invention, and, in point of etymology, quite inadmissible.

The story of the battle of the Centaurs and the Lapithæ, which formed so favourite a subject with Greek artists, is to the effect that Eurytion, a Centaur, having at the nuptial feast of Pirithous king of the Lapithæ, offered violence to the bride Hippodamia, was instantly slain by Theseus the friend of Perithous. The other Centaurs present sought to avenge the death of Eurytion, and to carry off the female guests. A general fight ensued: and war continued for some time with varying success between the combatants, but eventually the Centaurs were vanquished, and driven out of Thessaly. They found a refuge on Mount Pindus; but here they provoked the anger of Hercules, who destroyed the whole of the race.

The battle of the Centaurs and the Lapithæ forms the subject of the metopes of the Parthenon, part of which are now in the British Museum; and also one of the two subjects represented on the Phigaleian frieze, which is also in the British Museum. We give an example from each.



[From the Metopes of the Parthenon, now in the British Museum.]



[From the frieze of the temple at Phigalia, now in the British Museum.]

CENTAU'RUS, the Centaur, a southern constellation, a very small part of which rises in our latitude. It is situated under Virgo and Libra, and is evidently connected with LUPUS and ARA. From Ptolemy's catalogue, it is evident that he considered the Centaur as holding the wolf (or wild beast, as it is called) in one hand, and a thyrsus in the other; and from the proximity of the altar, it is plain that a sacrifice is alluded to. According to Grotius (notes on Aratus), the thyrsus anciently had a hare hanging from it. In some older figures, the Centaur holds a spear in both hands, which sustains the wolf, passing through its head. Hyginus makes only one constellation of Centaurus and Lupus.

The following are the principal stars in this constellation :—

Character.	No. in Catalogue of British Association.	Magnitude.
π	3866	3
λ	3941	4
δ	4087	4
ρ	4103	3
ϵ	4549	3
ι	4579	3
ν	4601	3
μ	4602	4

Character.	No. in Catalogue of British Association.	Magnitude.
κ	4623	4
ζ	4638	3
β	4669	3
θ	4686	3
η	4811	4
α^1	4831	4
α^2	4832	1

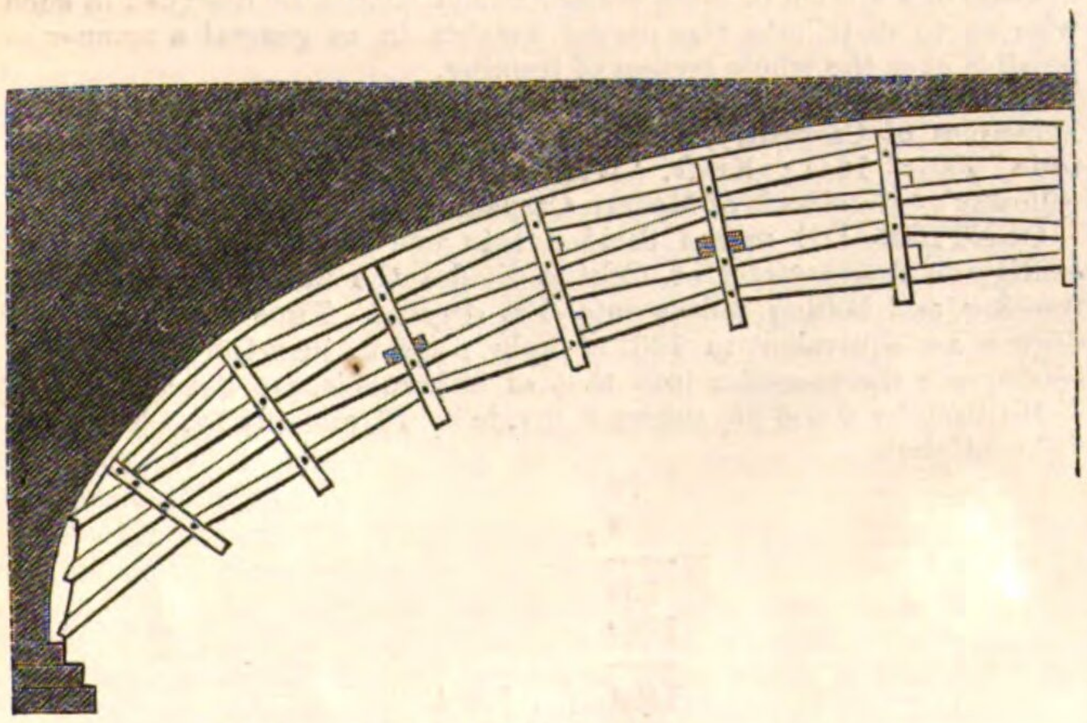
CENTERING. A centering, in building operations, is understood to mean a wooden, or other temporary, support, upon which the materials of an arch, whether of stone, brick, iron, or other substance, are supported during the execution of the work. Under these circumstances, the essential properties of a centre are that—1, it should be able to support the load to be placed upon it without sensible deflection; 2, that it should be easily and economically fixed; and, 3, that it should be susceptible of being easily and economically removed, without in any way endangering the solidity of the work it had previously supported. Evidently, local considerations must materially affect all these properties; for the width of the opening to be spanned by the centre, and the clear height to be left under the wood framing, must materially influence the modes of construction adopted in it; and thus pre-

cisely in accordance with the importance of the stream to be bridged will be the difficulty of constructing the centres to be used over it. In designing a centre, it must also be borne in mind, that the peculiar construction in question is distinctly a temporary one; and that therefore it should be put together in such wise as to allow the timber which enters into its composition to be reconverted, without material loss to the contractor from the waste of material, or the deep cuttings made into the said timber.

Centres may be described, nearly in the language of Tredgold, as being composed, in ordinary practice, "of several separate vertical frames, or trusses, connected together with horizontal ties, and stiffened by braces, in order to decompose the action of the vertical weights thrown upon the respective temporary structures intended to support them. It thence follows, from the peculiar nature of the resistances of timber to permanent efforts, that the various pieces of a centre should be made to receive their ultimate strains in a direction vertical to their length, as far as it is possible so to combine the framing; because, from the mere fact of the elasticity of the kinds of wood usually employed, the outline of the centre would be liable to deformation under the action of the permanent load, if that load should act either transversely or in a markedly inclined direction to the fibres of the wood employed. Even the Romans themselves seem to have been aware of this law, for they evidently made the centres of their arches of the very smallest possible span, in order to reduce the thrusts upon those centres to the most direct vertical action; and in the erection of the Pons Celsius of Rome, and in the Pont du Gard in France, it is evident that every advantage was taken of the dynamical resistance of the springing of the arches, to diminish the effort thrown upon the wooden framing intended to support the weight of the vault in the intermediate part. In both these cases it would appear, from the projections left upon the voussoirs, that the centres were made to rest upon the stones laid with an inclination of about 30° to the horizon, an inclination at which the friction upon the bed was only just balanced by the effects of gravity; and indeed it is more than probable, from the constructive details still to be observed in these bridges, that the Roman engineers adopted nearly the same modes of proceeding which are even now followed by practical builders in the execution of similar works. Amongst other facts to be gathered from the remains of antiquity which still survive in a tolerably perfect state, it would appear that even the modern sub-classification of close-boarded centres and of laggings was known to the Romans; and in the subsequent part of this article we shall have occasion to refer to the practical distinction between the two.

In small arches it is, of course, easy to make the centres of sufficient strength to resist the superincumbent weights, without producing any change of form in the outline of the vault; but in large arches the centres are so much exposed to vary in their outline, that it has been found advisable to admit at once the distinction between the flexible and the inflexible centres; and, in the cases of both these varieties, to further subdivide them into centres designed to receive the whole arc from the springings to the crown, and into the centres having intermediate supports,—or, in other words, into entire or into partial centres.

At the present day, the flexible centres used by Perronnet, in the construction of the bridge at Neuilly, are almost entirely abandoned; because the shape of the intrados of an arch, raised upon such a centre, must inevitably be exposed to changes of the most extraordinary and irregular nature. In fact, a centre of this description must always be liable to change its form, from the mere pressure of the voussoirs which are progressively added, and the only mode of obviating this inconvenience would consist in weighting down those parts of the centre

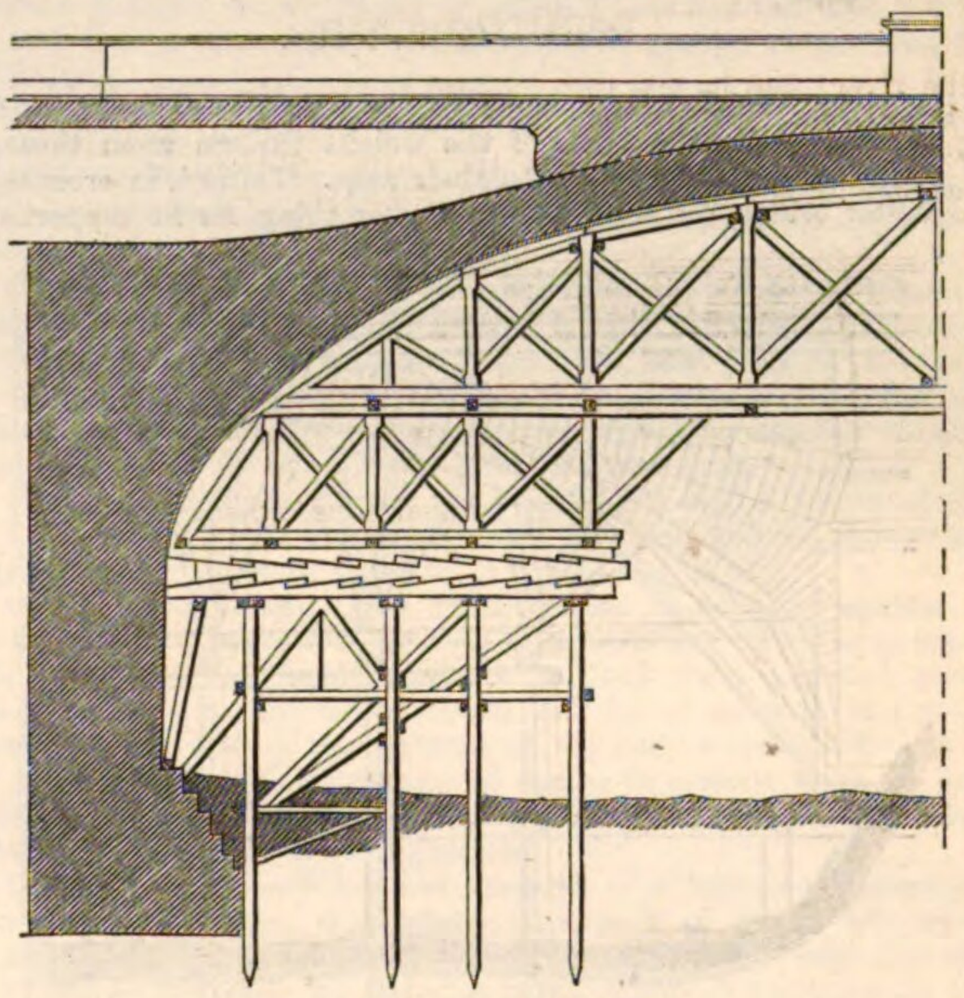


Centre of Neuilly Bridge.

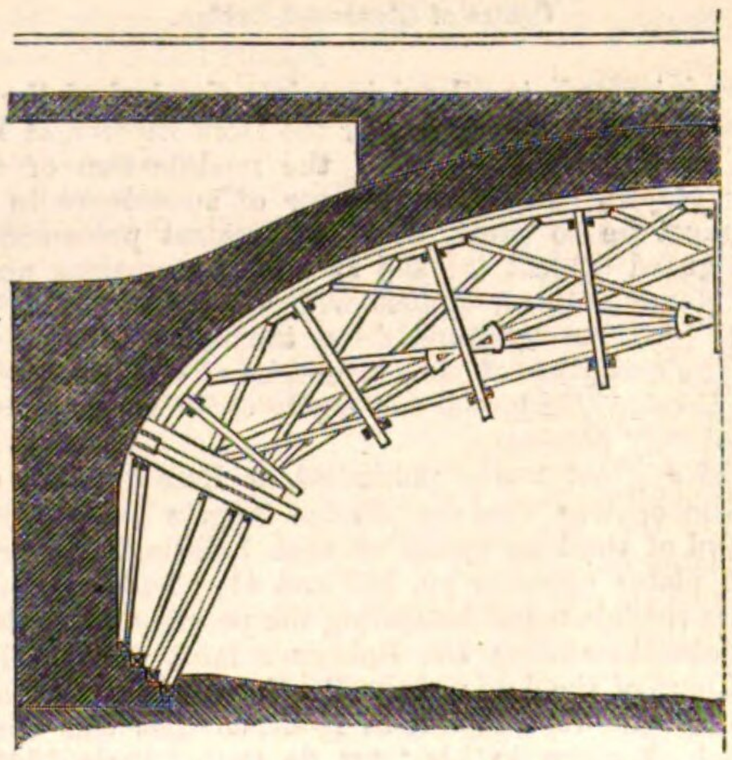
which did not immediately support the load. The success of any such operation must of course be always equivocal, and the great subsidence which took place in the masonry erected upon the centres of the Neuilly Bridge, may be referred to as proving the danger attending the application of the particular centre there used. In the article

Bridge, this has been already alluded to; and the extent of the settlement recorded in that case must be considered to be the most marked condemnation of the system adopted; but it may also be observed that in previous experiments the same results had been obtained, as in the case of the old bridge of Moulins over the Allier, erected by Mansard. The flexibility of centres like those used by Perronnet and Mansard, in the cases thus cited, arises from the perfect freedom of the timbers of which they are composed to move upon one another; but, by the same rule, it follows that precisely in proportion as the haunches are loaded in an arch of this description, the centre must rise at the crown, unless some artificial means be adopted to keep it from rising. As it is impossible to regulate these movements, it follows that the use of flexible centres must be abandoned in all cases where it is desired to secure the regularity of the curvature of the arches, and a rigid system of framing must be introduced, which, as before said, may either be supported upon the springing of the arches themselves, or upon intermediate points of support in the opening they are designed to span. In some cases centres are framed, designedly, to be supported in the commencement upon the springings only; and to be subsequently strengthened by intermediate struts, inserted during the progress of the work; and there appear to be really some important advantages in this system, for the centres can, under it, be more easily slackened than when there are no intermediate supports.

In the more modern centres, such as those used for the London and Waterloo bridges, one of the most serious sources of danger (namely, that arising from the number of butt joints) which occurred in the earlier descriptions of centres, was obviated by the use of cast-iron shoes; and, as will be observed, the timbers are made to support strains



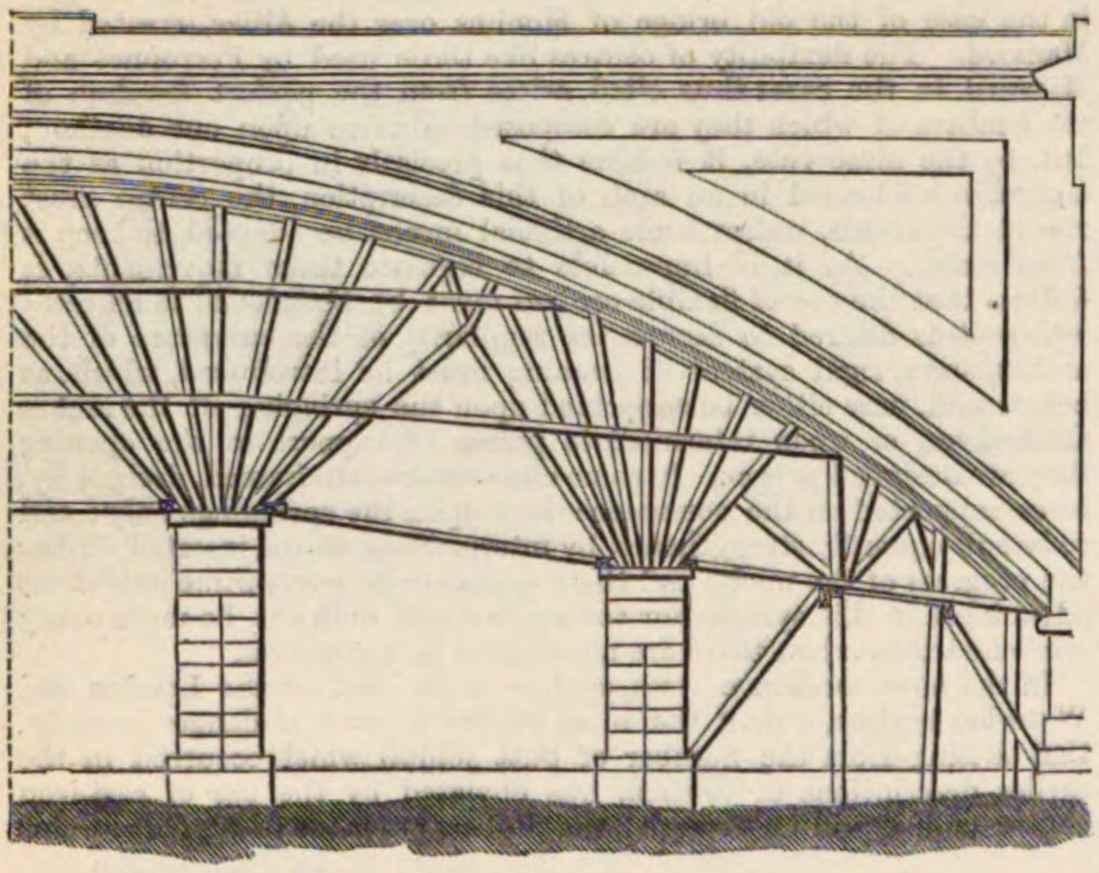
Centre of London Bridge.



Centre of Waterloo Bridge.

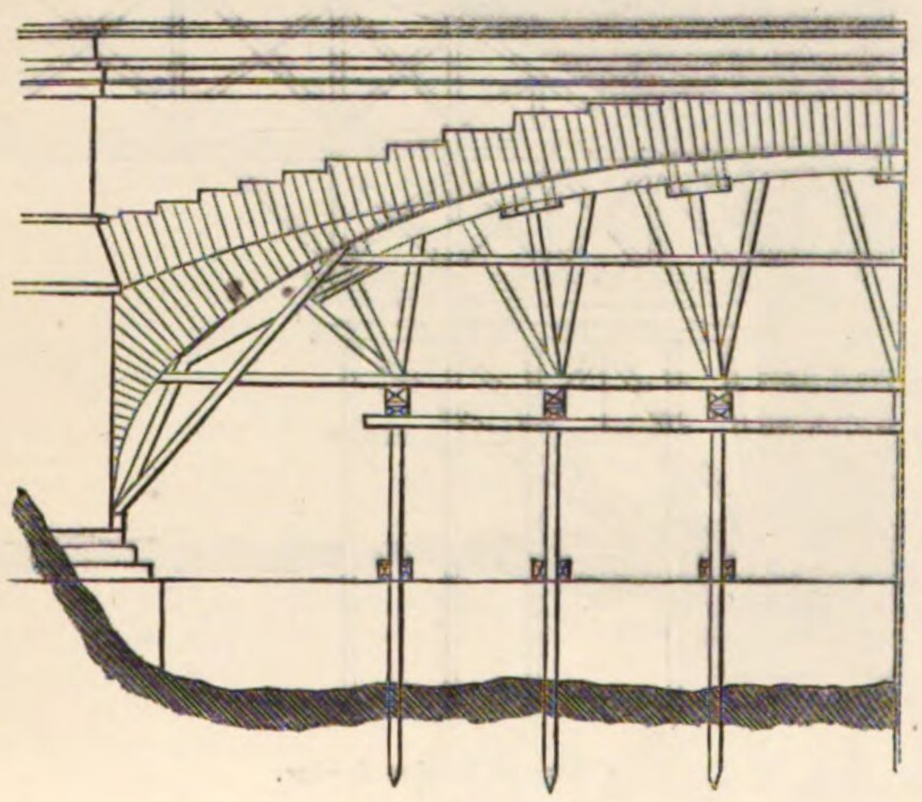
acting principally in the direction of their length. The cast-iron shoes also acted as ties to the whole of the framing, and thus prevented the centre from rising in any dangerous manner at the crown. But even in these cases it was necessary to carry up the arches evenly on either side, and to weight the centres temporarily at the summit.

In the case of the great Chester bridge, the largest span of any stone bridge executed of late years, the engineer, Mr. Harrison, supported the centre by means of four temporary piers erected in the water way



Centre of Chester Bridge.

of the river; and he was thus enabled to place the struts of his framing so as to receive the whole of the weight thrown upon them, in a direction but slightly oblique to their axes. Telford, in erecting the Gloucester bridge, did somewhat the same thing, for he supported his

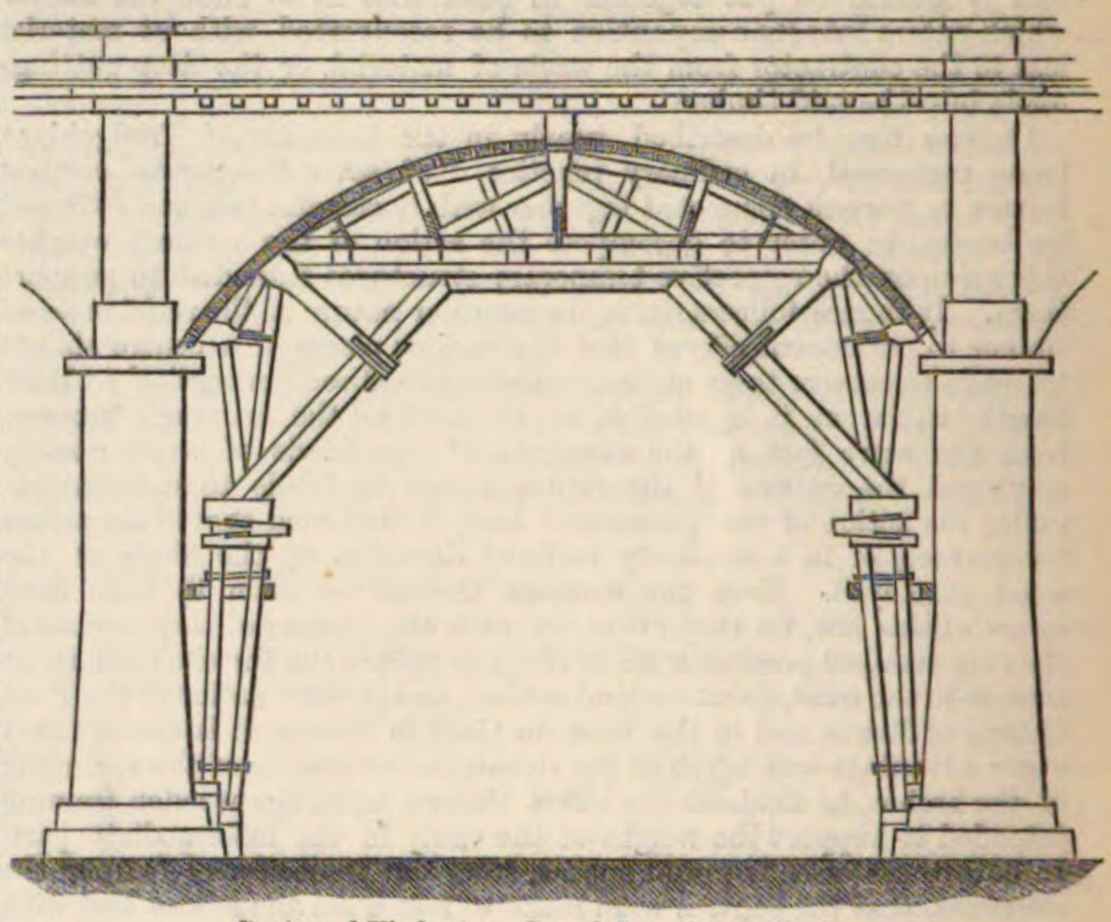


Centre of Gloucester Bridge.

centres upon intermediate piles driven into the bed of the river; and the engineer of the great bridge over the Dora Riparia, at Turin, introduced an intermediate support in the modification of the Neuilly centre he employed. In fact the danger of subsidence in a centre of large span must be so great, that the greatest precautions must be adopted to guard against it; and as such precautions necessarily involve great money outlays, it must evidently be preferable to diminish the necessity for them by diminishing the opening to be temporarily spanned. The execution of such triumphs of engineering skill as the centres of London Bridge, is too costly to be repeated oftener than may be absolutely necessary.

In Fontana's great work, published at Rome, 1694, 'Il Tempio Vaticano,' the centres used by Michel Angelo for the execution of the dome, and of the long vaults of that building, are very faithfully given in the plates opposite pp. 320 and 412; and they may still be referred to as models notwithstanding the progress of modern science, and even notwithstanding Dr. Robison's faint praise. In the construction of part of the dome of the Pantheon of Paris, Rondelet made every ring of voussoirs complete in itself, so that the centre he employed, which is given in his 'Art de Batir,' Paris, 1843, had but, comparatively speaking, little to do in supporting the weight of the masonry, in those portions at least; but when the rings of voussoirs were interrupted to receive the openings of the windows, a more complicated centre was required. The reader would do well to study this portion of Rondelet's work, for it contains some of the most valuable practical and scientific reasoning, on the action of arches upon their centres, to be found in any existing work on architecture; excepting, perhaps, the first volume of Robison's 'System of Mechanical Philosophy,' Edinburgh, 1822.

It has been already mentioned [BRIDGE], that the system of supporting the extremities of centres had been, until a very recent period,



Centre of Viaduct on Grand Junction Railway.

to place them upon a series of wedges, which were driven back when it was thought advisable to release the arches; and in the cases of London, Blackfriars, and Waterloo bridges such wedges were used. But it often happens that the grains of the woods used for the wedges, and the inclined ways, are driven by the superincumbent load into one another to such an extent that it is not possible to move them; and under such circumstances, it has occasionally been found necessary to cut away the points of support of the centres, and to let them fall, perhaps, abruptly. Even when the wedges move, the blows they require are likely to jar the masonry; and it was with a view of obviating this serious practical evil that the use of the sand-bags, described as having been applied on the Tours and Bordeaux Railway bridges (in the 'Annals des Ponts et Chaussées'), was introduced. It seems, however, that there are occasional difficulties attending the discharge of the sand from the vessels placed at the feet of the centres; and as under any circumstances it is preferable to employ centres with intermediate points of support, added subsequently to the placing of the great framing resting upon the springings, it may be sufficient to trust to the loosening of the centres by the gradual removal of the said intermediate supports.

In small centres, in centres for brick, concrete, rubble, or groined arches, the frames, which are usually spaced at intervals of about five feet, are covered with what is technically called "close boarding;" in centres for large openings, wherein ashlar masonry is employed, the courses of stones are supported upon "laggings," placed at right angles to the axis of the structure. In both cases precautions must be taken to prevent any lateral movement of the frames or trusses by the introduction of a system of cross braces, which should be designed in such wise as to distribute the partial weights in as general a manner as possible over the whole system of framing.

In addition to the works quoted above, see Tredgold's 'Elementary Principles of Carpentry,' Lond., 1840; Emy, 'Traité de la Charpenterie,' Paris, 1841; Kraft, 'L'Art de la Charpente,' Paris, 1805; Silloway's 'Handbook of Modern Carpentry,' New York, 1858.

CENTIGRADE means divided into one hundred degrees. The centigrade thermometer of Celsius divides the interval between the freezing and boiling points into 100 degrees. Thus 100 centigrade degrees are equivalent to 180° of Fahr.; and to turn the reading of a centrigrade thermometer into that of Fahrenheit, proceed as follows:—Multiply by 2 and 20, subtract, divide by 10, and add 32. Thus for 78° centigrade—

78
2
—
156
1560
—
1404 . . . 140·4
32
—
172·4 Fahr.

CENTRAL CRIMINAL COURT. This is a court established in 1834, by 4 & 5 Wm. IV. c. 36, for the trial of treasons, murders, felonies, and misdemeanours committed within the city of London and county of Middlesex, and parts of Essex, Kent, and Surrey. By s. 22

the court is authorised to try offences committed on the high seas and other places within the jurisdiction of the Admiralty of England, and by the 19 & 20 Vic. c. 16, the court of Queen's Bench may order certain offenders to be tried at this court. The justices of the peace were prohibited by the Act from trying at their sessions persons charged with capital and a variety of other offences, alleged to have been committed within the jurisdiction of the Act; but the restriction was repealed by the 14 & 15 Vic. c. 55. This jurisdiction comprises the whole of Middlesex; in Essex, the parishes of Barking, East Ham, West Ham, Little Ilford, Low Layton, Walthamstow, Wanstead, Woodford, and Chingford; in Kent, Charlton, Lee, Lewisham, Greenwich, Woolwich, Eltham, Plumstead, St. Nicholas's Deptford, that part of St. Paul's Deptford which is within Kent, the liberty of Kidbrook, and the hamlet of Mottingham; in Surrey, the borough of Southwark, the parishes of Battersea, Bermondsey, Camberwell, Christchurch, Clapham, Lambeth, St. Mary Newington, Rotherhithe, Streatham, Barnes, Putney, that part of St Paul's Deptford which is within Surrey, Tooting, Graveney, Wandsworth, Merton, Mortlake, Kew, Richmond, Wimbledon, the Clink Liberty, and the district of Lambeth palace.

For all purposes under the Act the above district is considered as one county, and in all indictments and presentments the venue runs "Central Criminal Court, to wit."

The judges of the Central Criminal Court are appointed by the Act to be any two or more of the following persons; the lord mayor for the time being of the city of London, the lord chancellor or the lord keeper of the great seal, and all the judges for the time being of his Majesty's courts of King's Bench, Common Pleas, and the Exchequer, the chief judge and the two other judges in Bankruptcy, the judge of the Admiralty, the dean of the arches, the aldermen of the city of London, the recorder, the common serjeant, the judges of the sheriff's court of the city of London for the time being, and any person or persons who hath or shall have been lord chancellor, lord keeper, or a judge of any of his majesty's superior courts of Westminster, together with such others as his Majesty, his heirs and successors, shall from time to time name and appoint by any general commission. The power of selecting the judges from so extensive a list renders it unnecessary to issue a commission every time the sessions are held, and the period of holding the sessions is not interrupted when the judges of the courts at Westminster are absent on circuit. The sessions are held twelve times a-year at the Old Bailey and in the New Court adjoining, and the judges are usually two of the common-law judges and the recorder of the city of London. Before the Central Criminal Court was established, sessions were held at the Old Bailey eight times a-year for the trial of offences committed in Middlesex, and bills were returned by a grand jury sitting at Clerkenwell under the jurisdiction of the county magistrates. Offences committed at Southwark or Greenwich, both of which places may be regarded as parts of the metropolis, were, in the case of Southwark, tried at Guildford, Kingston, or Croydon, as it might happen, and from Greenwich an offender was sent for trial to Maidstone. From the great amount of population, the calendars were necessarily so heavy that a winter assize became necessary for parts of the Home Circuit; but it was still better to place the whole metropolitan district under one jurisdiction, and to have a gaol delivery every four or five weeks.

Jurors are summoned by the sheriffs of the city of London and of the counties of Middlesex, Essex, Kent, and Surrey, according to the parts of the district in which they reside. The juries are selected from London alone; or from Middlesex, and the parts of counties which are within the limits of the act; or from both indiscriminately. Jurors from Essex, Kent, and Surrey, who have served upon any jury at the Central Criminal Court are exempted, for the ensuing twelve months, from serving upon any jury in any court (except the sessions of the peace) held in the county in which they reside.

By the Stat. 7 Will. IV. and 1 Vict. c. 77, the practice of this court was assimilated to other courts of criminal judicature with respect to offenders liable to the punishment of death; and by the 9 & 10 Vict. c. 24, indictments may be preferred before the grand jury of the Central Criminal Court in the same manner as before any other grand jury.

The area over which the jurisdiction of the Central Criminal Court extends is about the 130th part of the area of England and Wales, but the population is between one-seventh and one-eighth of that of England and Wales. Nearly as many prisoners are annually tried at the Central Criminal Court as at all the county assize courts in England and Wales.

CENTRE, from the Greek *κέντρον*, a sharp point. This word, by its successive introduction in one sense and another, has become a generic term for any point of a figure or solid body, such that the whole of the figure or body might be collected into that point, without any alteration except in some respect or other which is specified. It is, in fact, an average point, as the following species of it will show :—

1. *Centre of Cavity.* [METACENTRE.]

2. *Centre of a Curve.*—The point where any two diameters of the curve intersect one another. When all the diameters intersect at this point, Newton calls it the *general* centre.

3. *Centre of a Dial* is the point where the gnomon or style, which is generally parallel to the axis of the earth, intersects the plane of the dial.

4. *Centre of Figure.*—If any number of points be situated in given positions with respect to a plane (A), their average perpendicular distance from the plane is common to all the points of a second plane (B), parallel to (A). If two other planes (A′) and (A″) be taken, and if (B′) and (B″) be planes distant from them by the average distances of the points, then (B), (B′), and (B″) will meet in a point which is obviously distant from the three planes by the several average distances of the points. And it is proved, by the application of algebra, that the point thus determined is also distant from any other plane whatsoever by the average distance of the points; whence it may be called the centre of *figure* of the points. It is usual to call it the centre of *gravity*, which it is on one particular supposition only, namely, that the points are supposed to have *equal* weights.

A solid figure cannot be supposed to be made up of points; but if it be divided into a number of equal elementary portions, and if one point be taken in each, and the centre of figure then found in the manner just described, the principles and processes of the integral calculus will determine the centre of figure of the portion of space within the limits of the whole solid. This, as before, is only the centre of gravity, on the supposition that the solid is of uniform density throughout.

The centre of gravity may be made useful in finding the contents of surfaces and solids formed by revolution, as follows :—

i. If an arc revolve round an axis the surface traced out is equal to a rectangle, one side of which is equal in length to the arc, and the other to the arc of a circle through which the centre of gravity of the revolving arc passes.

ii. If an area revolve round an axis, the volume of the solid thus generated is equal to a cylinder or prism which has the area for its base, and the arc traced out by the centre of gravity of the area for its altitude.

These propositions are the foundation of what has been called the *centro-baryc* method.

5. *Centre of Force or Attraction.*—That point to which all the parts of a system are attracted by virtue of the force emanating from it, or inherent in it.

6. *Centre of Friction.*—This is a term now fallen into comparative disuse. It is that point in the base of a body on which it revolves, into which, if the whole surface of the base and mass of the body were collected, and made to revolve about the centre of the base, the angular velocity destroyed by friction would equal the angular velocity destroyed in the body by its friction in the same time.

7. *Centre of Gravity.*—This is the point at which the weight of the body being collected, the equilibrium of the body and of the system (if any), of which it forms a part, will not be disturbed.

8. *Centre of Gyration.*—This term, which is almost peculiar to English mathematicians, has the following meaning: it is the point at which, if the whole of the matter in a body were collected, given forces would produce the same angular velocity of rotation in a given time as they would do if the particles of the body were distributed in their proper places. This centre is of course dependent upon the axis of rotation as well as the form, &c. of the body; every axis which can be chosen has its own centre of gyration.

9. *Centre of a Lens.*—When the surfaces of a lens are concentric, the centre is, of course, equidistant from each of them; but when they are of different curvatures, the centre of the lens is nearer to one vertex than to the other, by as much as the radius of curvature of the former is less than that of the latter.

10. *Centre of Oscillation.*—The point in which the whole of the matter must be collected, in order that the time of oscillation may be the same as when it is distributed.

11. *Centre of Percussion.*—That point of a revolving body which would strike an obstacle with the same force as if the whole of the matter were collected in it.

12. *Centre of Pressure.*—The point at which the whole amount of pressure may be applied with the same effect as it has when distributed.

13. *Centre of Suspension* of a pendulum or other vibrating body having an angular velocity round a fixed axis, is convertible with the centre of oscillation, and hence is the point by which the body must be suspended in order to vibrate in the same time as if suspended by its centre of oscillation.

14. *Centre of Symmetry.*—That point in a figure or body round which the parts of it are similarly disposed, or have the same shape, size, &c., on each side. For methods of finding these several centres, see GRAVITY, &c., CENTRES OF.

In old writers, from the earliest periods, the term *centre* is used in the sense of a supposed centre of the universe, which it was imagined must coincide with the geometrical centre of the earth. And it was supposed to be a most obvious principle that all bodies must fall to this centre, which being a notion derived from the observation that all bodies fall towards the centre of the *earth*, was made an argument in favour of the stability of the latter. Even Copernicus has a notion of the existence of such a centre, or *medium mundi*, which, however, he places in the sun, while others consider one of the Pleiades to be the point in question. It is hardly necessary now to say that there is no evidence whatever for the existence of any centre of the universe, that is, of any point which must necessarily remain fixed; but so well

established was this notion in former times, that it was supposed even if the earth were to be annihilated, this centre would still exist with all its properties.

CENTRI'PETAL and CENTRI'FUGAL FORCES, forces which urge a body to *seek* (petere) or to *avoid* (fugere) a centre; in more modern language, attractive and repulsive forces. [ATTRACTION, REPULSION, FORCE, GRAVITATION, &c.]

We intend here to confine ourselves to the term *centrifugal force*, in one particular sense in which it is used in mechanics and astronomy, because it involves a point which is frequently mistaken. The term force, as used in mechanics, implies simply any cause of motion which is external to the matter moved; and the terms accelerating force, as well as retarding force, are used with reference to the velocities of bodies, and without reference to their masses or weights. So long as velocity remains unaltered, there is neither accelerating nor retarding force; when alteration of velocity begins, then we may say that force begins to act, for all we know of force is implied in the words, "cause of acceleration or retardation." Again, owing to the convenience of words implying causation, it is usual to give the name *inertia* to that property of matter by which it maintains its state, either of rest or motion, unless acted on by other matter. And since the state of matter left to itself is either that of rest or of uniform motion in a straight line, every other species of motion, of what sort soever, is an effect of force from without; which assertion is verified in every instance in which it can be tried.

Suppose we fasten a string to an immoveable obstacle, such as a post, and pull it, say with a force of a hundredweight. It may not at first sight appear proper to say that the post also pulls the string, because we may not be able to conceive the latter acting, but only resisting. Nevertheless, the part which the post sustains, call it action or resistance, is still the equivalent of a force, for if it were removed, and another hand applied to the other end of the string, that hand must also pull against the first with a force of a hundredweight before the counteraction of the moving tendency of the first pressure is supplied. And in calculating the numerical effects of pressures, the equations of motion can take no cognisance of the cause of the pressures, but only of their amounts; whence it will arise that the effect, say of the resistance of an immoveable obstacle, may enter an equation in precisely the same manner as a physical attraction [ATTRACTION], a muscular effort, or any other mode of accelerating or retarding velocity.

Next, it must be remembered that no alteration whatever of the effect of inertia can be produced without force of some kind. Let us now suppose a small bullet attached to a string, which string is fastened to a point upon a table, friction and the resistance of the air not being supposed to exist. Let the bullet be placed in a state of revolution round the fixed point by means of the string, and with a given velocity. It will continue to revolve round with the same velocity, and the string will be stretched by a pressure depending upon the mass of the bullet and its velocity. The reason of the permanence of the velocity is contained in a proposition which is demonstrated in mechanics, namely, that forces applied to a material point in the direction perpendicular to that of its motion cannot change its velocity, but only its direction. If, for instance, a hand could apply pressure to a moving point on a table, by means of a string, so adroitly as always to keep the pressure perpendicular to the direction of motion for the time, the whole amount of the pressure might be varied so as to make the point describe any curve, but always with the same velocity as at the outset. Now, in the present case, the bullet must describe a circle, and the direction of the string, in which the retaining pressure acts, is always perpendicular to the tangent of the circle, being always a radius. This pressure of the string must be caused by an effort to escape on the part of the bullet, arising from its tendency to continue its motion in the direction of the tangent. This is the centrifugal force, and does not arise from any tendency which the body has to fly *from* the centre, but from this circumstance, that there is in the motion above described a constrained approach *to* the centre, or rather a constrained continuance at the same distance from the centre, such as would not exist in the motion of the bullet uninfluenced from without.

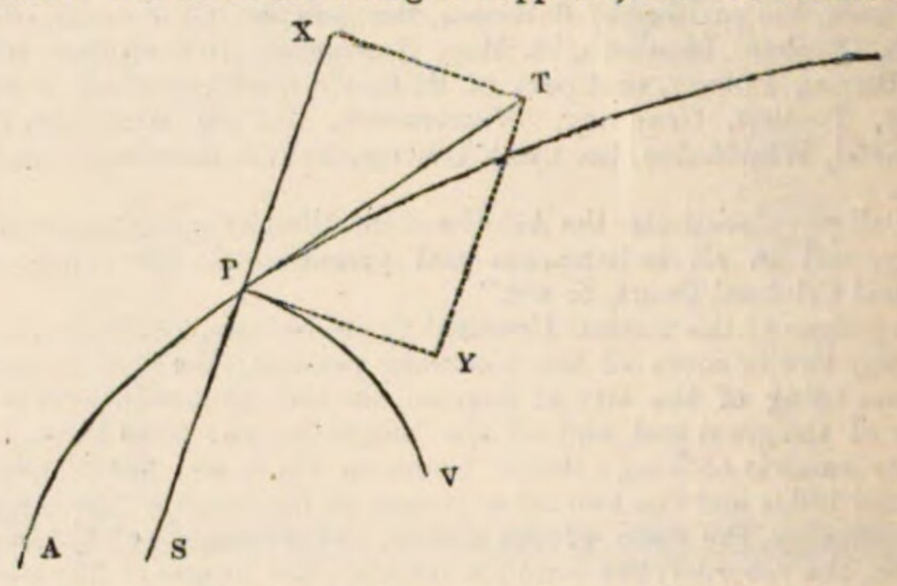
The centrifugal force is thus measured: suppose, for instance, the velocity of revolution in the circle to be 8 feet per second, and the radius 10 feet. Divide the square of the velocity by the radius, or divide 64 by 10, which gives 6·4. Then the pressure is such, that were it to take the place of the earth's attraction, the bullet, being allowed to fall, would, at the end of one second, have acquired a velocity of $6\frac{4}{10}$ feet per second, instead of $32\frac{1}{6}$, which is the case with bodies falling freely to the earth. And if we ask what weight must be hung to the string, so that it may receive the same pressure as when constraining a bullet of two pounds in weight to move at 8 feet per second in a circle of 10 feet radius, the answer is, such a proportion of the weight of the bullet as $6\frac{4}{10}$ is of $32\frac{1}{6}$,

$$\text{or } \frac{6\frac{4}{10}}{32\frac{1}{6}} \times 2 \text{ pounds, or on } \frac{384}{965} \text{ of a pound.}$$

If then this latter weight, hung at its end, would be the utmost the string would bear without breaking, then any accession of velocity in the preceding motion would also break the string.

We now take the case of one of the planets moving in the curve AP

about the sun at S, and attracted towards the sun, so that if reduced to rest for a moment at P, it would immediately begin to descend towards S. It must always appear to one not used to consider these subjects, that this attraction being perpetually exerted must at last make the planet fall into the sun. But suppose for a moment the attraction removed, so that the planet would pursue its course along PT. Prevent this by an inextensible string SP, in which case the planet will proceed in the circle PV, not with the whole velocity with which (but for the string) it would have proceeded along PT, but with a part, as follows:—Let PT be the length which would be described in a second, draw PY perpendicular to SP, and complete the rectangle PXTY. Then the velocity PT might be produced, if the string were not there, by an instantaneous communication of the two velocities PX and PY in these directions. But when the string is supposed, the communication of

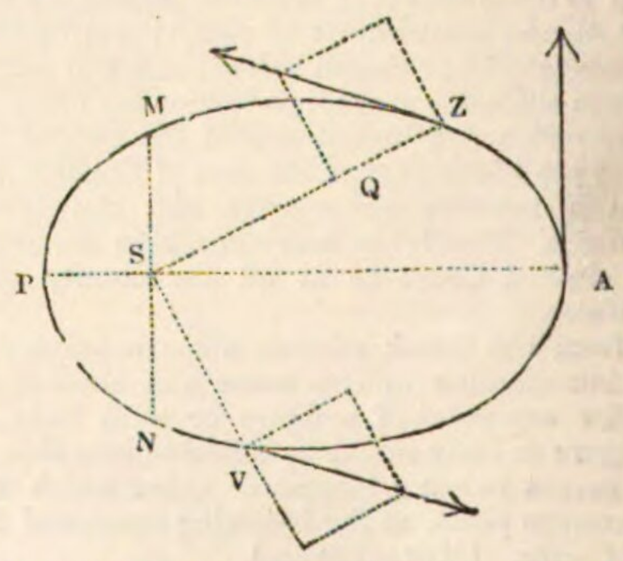


such an impulse as would produce PX has no effect except an instantaneous tension of the string, which is supposed capable of resisting it. There remains only PY, which would produce what has been before called the centrifugal force.

Now, if the string were not there, there remains the body P, with the same tendency to recede from the centre implied in its having the velocity PY, and with the effect, which would be counteracted by the string, entirely uncounteracted. If then we look at the *paracentric* motion only, or the manner in which SP is lengthened or shortened, independently of the angular motion, we have, 1. the paracentric velocity PX actually existing; 2. the attraction of S in the direction PS; 3. the tendency to recede from the centre arising from the velocity PY. The alteration of the first is not due to the second or third alone; if (2) exceeds (3) the velocity PX is diminished in the instant next following the body being at P; if (3) exceed (2) it is increased.

To realise the supposition above alluded to, namely, that the attractive force must bring the body P to the centre at last, we must put that force in a situation to act unopposed. Imagine a string which shortens as the body approaches the centre, so as always to remain stretched; and *also* suppose the attractive force to act, the effort to proceed in the tangent of the circle being destroyed by the string, and we have the case which is really supposed in the above mistake, for want of considering the centrifugal force.

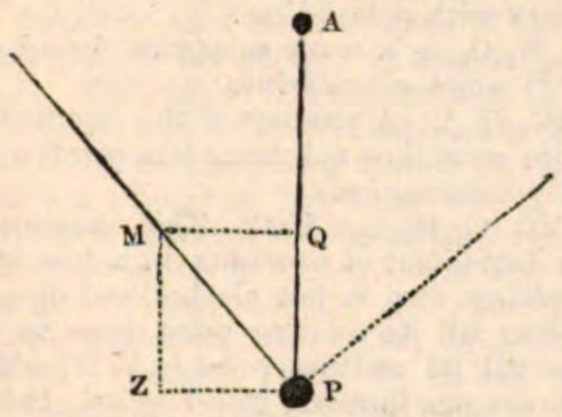
The centrifugal force always (whatever the attraction may be) varies as the inverse *cube* of the distance, while the attractive force varies as the inverse square. Consequently if the revolution ever bring the body to 1-10th its primitive distance, the attraction is only 100 times as great as at first, while the effort to recede is 1000 times as great. Hence a very little knowledge of algebra will make it apparent that however much the external attraction may at first exceed the centrifugal force, there must come a point of approach to the centre at which the latter begins to exceed the former. And hence the alternate approach and recession of the planets to and from the sun. Let AZMPNV be the ellipse of a comet's orbit (we have



drawn it too elongated for that of a planet), A and P the aphelion and perihelion, AP the axis, and MN a perpendicular to it. Let the planet be projected at A with the necessary velocity: then from A to M the attraction exceeds the centrifugal force, and velocity towards the centre is created, as instanced by ZQ in the figure at Z. At M the attractive and centrifugal forces are equal, and from M to N the centri-

fugal exceeds the attractive, so that between M and P the velocity towards the centre is destroyed, and from P to N velocity *from* the centre is created. After N the attraction is again in excess, and between that and A the velocity from the centre is destroyed; after which the succession recommences.

Some readers may perhaps not find it easy to conceive how the centrifugal effect should exist, when the pressure of the string, which it appears to counterpoise, is not present. On which we must observe that the string does not make this effort to recede, but destroys its effect. If it is clear that there must be a pressure on the string in the first illustration, it is because, under the circumstances, there is a force to cause that pressure already existing. There are numerous experiments in illustration of centrifugal force: take a tube, for example, and place a bullet inside it; let the tube be then put into a state of rotation round one end, and the bullet will be projected straight from it. The governor of a mill or steam-engine is an instance in which this effort to recede is made useful. But the largest scale on which the centrifugal force becomes visible is in the alteration of the time of oscillation of a pendulum in going from one part of the earth to another. Let A be the point of suspension of a pendulum P, and P M



the line drawn through it perpendicularly to the earth's axis, so that the angle A P M is the latitude of the place. The motion of the earth carries the pendulum round in a circle of which P M is the continuation of the radius, so that there should be a slight action on the pendulum, such as should result from a pressure in the direction P M. Resolve this into P Q and P Z; the second will alter the position of equilibrium of the pendulum, the first will counteract a small part of the weight. The second will never be made visible; nor the first, except in comparing the number of oscillations of the same pendulum in different places. For the weight of the pendulum being differently lessened in different places, but the mass always remaining the same, the accelerating force is altered. For the law of the alteration, and the history of its discovery, see PENDULUM.

CENTUMVIRI. [JUDEX.]

CENTURION. A centurion in the Roman army was the commander of a centuria, a term which we cannot conceive to have originally signified anything except a hundred; but there is no ground for supposing that the word centuria contains the elements of the word "viri," men. The term centuria was also applied to a hundred jugera of land; and Varro ('L. L.' v. 35) observes that the name was kept after the centuria contained two hundred jugera.

A centuria, as a division of an army, signified a number of men under the command of a centurio. The form of the word centurio is the same as that of the word curio. Niebuhr has endeavoured to show that the centuria originally consisted of thirty men ('Roman History,' vol. i. 471, iii. 100, Eng. Transl.) When the Roman legion contained thirty manipuli and sixty centuries, the number of the centurions would be sixty; but as the number of the legion was not a fixed number, we must suppose that the officer called a centurion had at various times a varying number of men under him.

The passage in Livy (xlii. c. 32, &c.) seems to show that the centurions were appointed by the military tribunes. But Polybius, in the fragment of his sixth book (c. 24), states that in his time twenty men were selected from the respective bodies of the hastati, principes, and triarii, who composed a legion: none were selected from the velites, or light troops, who were distributed among the hastati, principes, and triarii in just proportion. Polybius calls the Roman centurion *taxiarchus* (ταξίαρχος), which is a translation of the Latin phrase "ordinem ducere." There were two centurions to each of the divisions, or manipuli, as the Romans called them; and he that was first chosen commanded the right of the manipulus, and the other the left. Each manipulus had its standards, which were carried by two of the bravest and strongest soldiers, who were appointed by the centurions. The centurion who was first chosen was called primipilus, and was a member of the general's council: he was the first centurion of the first manipulus of the triarii, and he had the care of the eagle.

The pay of the soldier in the infantry, besides food and clothing, is stated by Polybius at two oboli a day, and double to the centurions. The obolus is a sixth part of the Attic drachma, or one-sixth part of $9\frac{3}{4}d.$ This would therefore make the pay of a centurion about 16*s.* a month; by the time of Domitian it had been increased tenfold.

The duties of the centurions were to command their several manipuli. They received their orders from the tribunes of the legion, who received theirs from the commander of the army, whom they visited every morning to receive their orders, which they then gave to the centurions. They also superintended the soldiers when they were engaged in the military works, such as castrametation. They had also to go round to inspect the watches; at least this is stated as among the duties in some passages of the Latin writers. The badge of office was a stick made of the stock of a vine (vitis). The speech of the centurion Sp. Ligustinus in Livy (xlii. 34), presents a lively picture of the laborious services of a Roman soldier who had worked his way up to the rank of Primipilus.

The centurions had defensive armour, a shield, an iron helmet with a crest placed transversely to distinguish them from the soldiers. They had also a mark (signum) on their helmet, probably to denote the centuria or cohort to which they belonged. ('Vegetius,' ii. 13; and the Notes of Stewechius.)

The granting of temporary leave from military service to the soldiers (vacatio), which is sometimes reckoned among the privileges of the centurions, was only an abuse that got established at a late period. It appears to be first mentioned in the beginning of the reign of Tiberius (Tacitus, 'Ann.' i. 17). However, the practice had become so far established that Otho thought it prudent to pay the centurions out of the imperial treasury (fiscus) such amounts as they had been in the habit of receiving from the soldiers on the account of the vacationes. Retired centurions had pensions: Suetonius mentions that Caligula reduced them to 6000 sesterces, or about 45*l.* per year.

Under the empire it seems that the centurionships were generally given as a matter of favour and patronage.

CEPHALOTE. This name was applied to a substance found in the brain of man, but which has more recently been proved to be a mixture of cerebrate of lime or soda with traces of albumen and of oleophosphoric acid.

CEPHEUS, a constellation, surrounded by Cassiopeia, Ursa Minor, Draco, and Cygnus, comes on the meridian at midnight in the middle of August, and at eight o'clock in the middle of October. A line drawn from the bright star in Cygnus to the Pole Star will be nearly bisected by α and η of this constellation. Cepheus, the King of Ethiopia, was the husband of Cassiopeia and the father of Andromeda, and was placed in the heavens, according to Hyginus, that no one of this remarkable family might be absent. He is represented in old plates as a man with a tiara on his head, kneeling on one knee, and with his arms extended.

The following are the principal stars in this constellation:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
η	3	7220	4
α	5	7416	3
β	8	7493	3
ϵ	23	7778	4
δ	27	7848	4
ι	32	7967	4
γ	35	8238	3

CERAMIC ART. [PORCELAIN; POTTERY.]

CERASIN is that part of the gum of the cherry-tree which is insoluble in cold water. It is probably some transitionary form between starch and gum.

CERATES, the name given to certain combinations of wax with other substances, which are used as external applications in the treatment of various surgical cases. They are of a degree of consistence intermediate between that of plasters and that of ointments; and, according to the nature of the materials united with the wax, are capable of serving different ends. They may be emollient, when applied to inflamed or chapped surfaces, or stimulating, when applied to indolent ulcers; and in the case of wounds or abraded skin are useful in excluding the air, and preventing the dressings from adhering.

CE'RBERUS, the watch-dog of the infernal regions, the offspring of Typhon and Echidna. Homer mentions him simply as the dog of Hades. He is first named Cerberus by Hesiod, who speaks of him as having fifty heads; according to Horace, he had one hundred; the ordinary account gives him only three, and this number, which corresponds to the triple form in which Geryon and Hecate appear, points to the usual phenomenon in the elementary worships of ancient Greece, in which a power of the nether world was also a terrestrial and celestial divinity. The Chimæra was another monster of the same kind. Cerberus was also the name of a serpent which infested the neighbourhood of Cape Tænarus. The word probably signifies "dark;" Cerberian occurs as a synonym for Cimmerian in Hesychius. Nicander applies it as an epithet to a toad. (Dahler, *Lex.* voc. peregrin.; Steph., *Thes.* ed. Lond., i. p. xxxii.)

CEREBRIC ACID, formerly called cerebrin, is a substance said to exist in the fatty matter of the brain. It is accompanied by another acid, the *oleo-phosphoric acid*, which is supposed to be united to a compound radical *cerebroleine*, in the manner of the fatty acids. These substances are of a very doubtful nature, and the chemistry of the nervous system is at present in a very imperfect state.

CEREBRIN. [CEREBRIC ACID.]

CEREBROLEINE. [CEREBRIC ACID.]

CEREBROTE. A name applied to a substance obtained from the human brain, but which is now known to be merely a mixture of cerebric acid, cerebrate of lime, cerebral albumen, &c.

CERENE ($C_{54}H_{54}$), is a solid wax-like body, derived from bees'-wax. It is now believed to be identical with paraffin.

CERES. [DEMETER.]

CERES, one of the group of small planets, but the largest except Vesta, which revolve between Mars and Jupiter.

CEREVI'SIÆ FERMENTUM, *Medical properties of.* Yeast, barm, or zumin has been known as long as fermented drinks, being the active or exciting agent by which they are formed out of saccharine juices. [WINE.] The intimate nature and mode of action of ferments have been studied with great care by Turpin, Cogniard Latour, Schwann, Liebig, M. Rousseau ('Comptes Rendus,' No. 17, April 24, 1843), and Bouchardat ('Comptes Rendus,' and 'The Chemist,' vol. v. p. 401.) These observers have established numerous differences in ferments; but it is to the common yeast of beer-brewers that the following observations apply. Its presence, or that of any gluten-like material, excites in saccharine fluids an intestine motion, by which, if there be sufficient yeast, the sugar is resolved into alcohol and carbonic acid. It is while this change is taking place that yeast is deemed most useful. It is employed both internally and externally. In the former case, the malt which supplied the saccharine principle has often been given along with or instead of it, under the name of malt or wort. It was highly commended by Dr. Macbride, in the treatment of scurvy, before the utility of lemon-juice was generally recognised; and some recent writers have given instances of its advantageous employment. The objection to its use is, that it generally increases the diarrhœa; but this is not invariably the case. It has been strongly recommended by Dr. Stoker of Dublin in typhus fever; and enemata made with it have proved useful against typhoid tympanites. All this is extremely probable, from the explanation given by Liebig of the manner in which ferments promote the digestive process. ('Animal Chemistry.')

The yeast poultice is an excellent application to putrid and gangrenous ulcers, with offensive discharge and unhealthy granulations. It must be renewed every six hours. Its beneficial influence is not owing solely to the carbonic acid gas evolved, as the same good effects do not follow when a stream of carbonic acid gas is directed on the sores. Dr. Stephen Williams of the United States strongly recommends a poultice of fine malt and boiling beer, with yeast spread on the surface, applied frequently in the twenty-four hours. Under its use the offensive odour and discharge cease, the granulations become firm and healthy, and the healing process goes on steadily. It is expedient to continue its use for three or four days. ('American Journal of Medical Science,' May, 1832, p. 38.)

German yeast, which is in a dry state, and begins its action on being moistened with water, has the advantage over common yeast of being more rapid in its development and effects. When used, it must be more frequently renewed..

Yeast has recently been recommended in the treatment of boils, which have prevailed epidemically; but there can scarcely be a doubt that well-fermented porter is as beneficial, and more grateful.

CERIC ACID. An acid body obtained by the action of nitric acid upon a wax-like substance found in cork. Its exact composition is not known.

CERIC ALCOHOL. [CEROTIC ACID.]

CERINE. [BEES'-WAX.]

CERIUM, ORES OF.—1. *Cerite,* found near Riddarhittan, in Sweden; it occurs amorphous. Its colour is pale dull red, sometimes grayish, and its streak is white; its lustre is resinous, slightly translucent, and sufficiently hard to give sparks with steel, or 5·5. Sp. gr. 4·912.

According to Hisinger, it consists of

Silica	18
Peroxide of cerium	68·59
Peroxide of iron	2·00
Lime	1·25
Water and carbonic acid	9·60
	99·44

Dr. Thomson considers it as a hydrous silicated peroxide of cerium.

2. *Cerine,* found as above; occurs massive and in imperfect crystals. Colour brownish-black, streak brownish-gray opaque, with an imperfect metallic lustre. Hardness, 5·5 to 6·0. Sp. gr. 4·173. Composition according to Berzelius:

Silica	30·17
Oxide of cerium	28·19
„ iron	20·72
„ copper	·87
Alumina	11·31
Lime	9·12
	100·38

3. *Allanite,* found at Alluk, East Greenland. It occurs massive, and crystallised in the form of a doubly oblique prism. Fracture imperfect conchoidal. It is opaque, with an imperfect metallic lustre. Colour brownish-black, streak greenish gray. Hardness, 6·0. Sp. gr., 4. It is composed according to Stromeyer, of

Silica	33·021
Protoxide of cerium	21·600
„ iron	15·101
„ manganese	0·404
Alumina	15·226
Lime	11·080
Water	3·000
	99·432

These are among the principal ores of cerium, but for an account of some others, consult Phillips's *Mineralogy,* and Dana's *Mineralogy.* See also Watts' *Memoir on Phosphocerite* in *Journal of the Chemical Society,* vol. ii. p. 131.

CEROLEIN. A soft fusible substance obtained from bees'-wax. It is probably a mixture, and not a distinct chemical compound.

CEROSIC ACID ($C_{96}H_{96}O_6$?). A white crystalline acid produced by treating CEROSIN with potash lime.

CEROSIN, $C_{48}H_{45}O_2$, is a waxy substance found on the surface of the sugar-cane. It is not saponifiable.

CEROTENE ($C_{54}H_{54}$). A product of the dry distillation of Chinese wax. It is a white crystalline substance like paraffin with which latter body it is probably homologous.

CEROTIC ACID ($C_{54}H_{53}O_3 + HO$). This compound was discovered by Brodie as an ingredient of bees'-wax in a free state. It may be procured by dissolving wax in hot alcohol, and dissolving the residue deposited on cooling till its melting point rises to 162°. It is then purified by ether till its melting point is 171°, which is that of the acid. This substance was formerly called *cerine.* It has, however, acid properties, and combines readily with bases. It combines with oxide of ceryl, forming the cerotate of that substance, $C_{54}H_{55}O + C_{54}H_{53}O_3$, which is called *cerotine.* When heated with potash, it produces cerotate of potash and the *hydrated oxide of ceryl,* or *ceric alcohol* ($C_{54}H_{55}O$, HO). [BEES'-WAX.]

CEROTIC ETHER ($C_{54}H_{53}[C_4H_5]O_4$). The compound of cerotic acid with oxide of ethyl. It is a wax-like body.

CEROTINE. [CEROTIC ACID.]

CERTIORARI, in law, is a writ issuing from one of the superior courts, directing the judges or officers of an inferior court to transmit or cause to be certified (*certiorari facias*) records or other proceedings. The object of the removal is either that the judgment of the inferior jurisdiction may be reviewed by the superior court, or that the decision and the proceedings leading to it may take place before the higher tribunal. An instance of the former is where the convictions of magistrates or the judgments or orders of courts of quarter-sessions are removed by certiorari into the Court of Queen's Bench by way of appeal against their validity, in which case the decision which has previously been given is re-considered, and is either confirmed or set aside. An instance of the latter is where an indictment found against a peer by an inferior jurisdiction is certified or transmitted into the Court of Parliament or the Court of the Lord High Steward, in order that the further proceedings and the adjudication may take place before the proper tribunal. By this writ, indictments, with the proceedings thereon, may, at any time before actual trial, be removed from the assizes or quarter-sessions into the Court of Queen's Bench, as the supreme court of ordinary criminal jurisdiction. A certiorari for this purpose was formerly granted on the application of a prosecutor as a matter of right; but by 5 & 6 Will. IV. c. 33, it is enacted that no certiorari shall issue to remove indictments or presentments from inferior courts to the Court of Queen's Bench, at the instance of a prosecutor, without leave obtained from the court, as by a defendant, and by the same statute, whether removed at the instance of a prosecutor or of a defendant, the party removing must enter into a recognisance to pay the costs subsequent to the removal in the case of acquittal or conviction, as the case may be. The 16 & 17 Vict. c. 30, s. 4, has limited the removal of indictment by certiorari. After reciting that by reason of the establishment of a Court of Criminal Appeal, the removal of indictments by writ of certiorari is seldom necessary for the decision of questions of law, but is nevertheless sometimes resorted to for purposes of expense and delay, it enacts that no indictment except against bodies corporate, shall be removed into the Court of Queen's Bench, or into the Central Criminal Court, by writ of certiorari, either at the instance of the prosecutor or the defendant (other than the attorney-general acting on behalf of the Crown) unless it be made to appear by the party applying that a fair and impartial trial cannot be had in the court below, or that some question of law of more than usual difficulty and importance is likely to arise upon the trial, or that a view of the premises should be taken in respect whereof any indictment is preferred, or a special jury may be required for the satisfactory trial. In order to avoid the occurrence of frivolous appeals, it is usual in statutes which give summary jurisdiction to inferior tribunals to restrict, or altogether take away, the right to a certiorari. The removal of cases from the county courts is specially provided for by the statute 19 & 20 Vict. c. 108, s. 38.

CERULO-SULPHURIC ACID. [INDIGO; *Sulphindigotic Acid.*]

CERUSE. [Lead, Carbonate of.]

CERVUS E'LAPHUS (Hartshorn), *Medical properties of.* The hart or stag is too familiar to require any description. The antlers shed annually yield the part used in medicine, called *Cornu cervinum*, the shavings or raspings of which are termed *rasura* or *ramenta*. These differ from the hollow horns of oxen, and approximate more to bones, from which they are distinguished by having less phosphate of lime and more gelatine. Merat-Guillot gives as the constituents: soluble cartilage (gelatine), 27·0; phosphate of lime, 57·5; carbonate of lime, 1·0; water and loss, 14·5. The gelatine is readily extracted by boiling water, and its abundance is such that one part to two of water, reduced by boiling to two-thirds or three-fourths, furnishes a consistent jelly. This is in general easily digestible, and suitable to convalescents. It may be flavoured with orange or lemon, and wine be added or withheld according to circumstances. This jelly mixed with equal parts of cow's milk is said by Dr. Thomson to be useful in irritations of the digestive organs of infants. The same good effect will often result from the addition of a small portion of lime water to the milk.

The phosphate of lime procured by incineration of hartshorn is ordered to be employed in preparing the Pulvis Antimonialis.

Hartshorn was formerly used as the source of ammonia; hence it was termed volatile spirit of hartshorn. [Ammonia.]

CERYL ($C_{54}H_{55}$). The radical of ceric alcohol. [Cerotic Acid].

CE'SSIO BONO'RUM, in the law of Scotland, is the name given to a process by which, as by the insolvency system in England, the estate of an insolvent person who does not come within the operation of mercantile bankruptcy is attached and distributed among his creditors. Both the nomenclature and the early practice of the system are taken from the Roman law. ('Dig.' 42, tit. 3.) According to the more ancient law, the person released from prison on a cessio bonorum was bound to wear a motley garment called the dyvour's habit. In later times this stigma became the penalty of fraud, and it was subsequently disused. Cessio bonorum exhibits, like the insolvency system in England, this important difference from mercantile bankruptcy, that the person who obtains the privilege is not discharged from his debts, but only from proceedings against his person for payment of past debts, his estate continuing to be liable to the operations of his creditors. In Scotland, however, the common law means of attaching a debtor's property are simple and effectual, and there does not appear to have been there the same inducement as in England to make the process for the distribution of the debtor's effects an instrument of their discovery. The Scottish system, moreover, cannot be used by the creditors as a means of compelling their debtor to distribute his estate. It is a privilege of the debtor, and being seldom resorted to except by persons in a state of destitution who are harassed by vindictive creditors, the improvement of the system has not been a matter of much interest either among lawyers or legislators.

CESSION. When an ecclesiastical person accepts a second benefice or dignity in the church, which is incompatible by law with that which he previously held, the latter is said to be void by cession. This avoidance takes place *ipso facto* upon the acceptance of the second benefice; and the patron may at once, without any sentence of deprivation in the spiritual court, and without any express resignation, present a new incumbent, and require his admission. By the statute 21 Hen. VIII. c. 13, s. 9, if a person, possessed of a benefice with cure of souls of the yearly value of 8*l.* or above, accept and take any other benefice with cure of souls, without a dispensation to hold both, the first is declared to be wholly void in law. But even if the first benefice be under the value of 8*l.*, and for that reason not within the statutory provision, it becomes void by the canon law as against the patron, in consequence of the acceptance by the incumbent of a second benefice or dignity. (Burn's *Ecclesiastical Law*, tit. *Avoidance and Lapse*; Blackstone, vol. i. p. 396.)

CESTUI QUE TRUST. [Trust and Trustee.]

CETENE. [Cetine.]

CETIC ACID is, according to M. Heintz, one of the acids that, combined with oxide of cetyl [Cetyl, Oxide of], form cetine [Cetine].

CETINE ($C_{64}H_{64}O_4$). The name usually given to the crystallisable matter which forms the greater part of the substance called spermaceti. In order to obtain it pure, the spermaceti must be treated with boiling alcohol, and the clear solution, on cooling, deposits cetine, which, if requisite, is to be purified by a second solution in, and deposition from, alcohol.

Cetine is white, crystalline, soft to the touch, and friable; it is nearly inodorous, is tasteless, and does not act upon litmus; it fuses at 120° Fahr. When distilled in vacuo, it is volatilised without change; but when heated in a retort in the usual way, it yields a liquid hydrocarbon called *cetene*, and ultimately a large proportion of a solid crystalline substance, *palmitic acid*, traces of charcoal remaining in the retort. One hundred parts of boiling anhydrous alcohol dissolve 15·8 of cetine; but when its specific gravity is ·834, only three parts are dissolved. If one part of cetine, an equal weight of hydrate of potash, and two parts of water are digested at a temperature between 122° and 194° Fahr. for several days, a soap is formed which is different from other soaps, combined with an unsaponified fatty matter, which Chevreul calls *ethal*. [Cetyl, Hydrate of.] When this soap is decomposed by an acid, the ethal is separated with the acids; 100 parts of cetine thus treated, give 60·96 parts of these acids, and 40·64 of ethal, the increase of weight amounting to 1·6. According to Chevreul the acids separated by and combined with the potash are margaric and oleic; Heintz asserts them to be stearic, palmitic, myristic, cocinic, and cetic; while the analyses of Stenhouse and Smith show cetine to be simply palmitate of cetyl. The products of the oxidation of cetine by nitric acid (œnanthylic, adipic, pimelic and other acids), are the same as those produced under the same circumstances from suet, wax, and other fatty matters.

CETRARIA ISLANDICA. [Iceland Moss.]

CETRARIC ACID—*Cetrarine* ($C_{36}H_{16}O_{16}$?). A white crystalline acid, found in Iceland moss, and communicating to the latter its peculiar bitter flavour.

CETRARINE. [Cetraric Acid.]

CETUS, the sea-monster, called Pistrix by Hyginus, and Orphus by some of the Greeks, is said to represent the monster which is going to devour Andromeda. It is situated below Pisces and Aries, and a bright star in the head, called Menkar (*α* Ceti), comes on the meridian at eight o'clock in the beginning of January. It is usually drawn with a fish's head, two paws in front, and a curled fish's tail. The following is a list of the principal stars:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
ι	8	62	3
β	16	196	3
η	31	332	3
τ	52	536	3
ζ	55	565	3
υ	59	618	4
ο	68	720	2
ρ	72	754	4
σ	76	781	4
δ	82	811	3
ϵ	83	815	3
γ	86	837	3
μ	87		4
π	89	847	4
α	92	949	2

CETYL ($C_{32}H_{33}$), an organic radical of the CnHn+1 series, and therefore homologous with methyl, ethyl, amyl, &c. Like them, in compounds it takes the place of hydrogen or a metal. [Organic Radicals.] The principal terms only of the cetylic group of bodies will here be described; the most important, because the one from which all the others are directly or indirectly derived, is

Hydrate of cetyl $\left(C_{32}H_{34}O_2 = C_{32}\begin{matrix}H_{33}\\H\end{matrix}\right\}O_2\right)$; *cetylic alcohol: ethal.*—Ordinary fats, when saponified with an alkali, yield certain acids, and the base glycerin. Spermaceti, however, when treated in the same way, yields certain acids and the base *ethal*. Both glycerin and ethal are alcohols, though belonging to different series and different classes; ethal containing a radical of the CnHn + 1 series, and of the monatomic class; that is, as seen by its formula, its radical replaces one atom of hydrogen in one double atom of water $\begin{matrix}H\\H\end{matrix}\}O_2$. Ethal, in fact, differs only from ethylic alcohol, or ordinary spirit of wine, $\left(\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2\right)$, in containing the radical cetyl ($C_{32}H_{33}$) in the place of the radical ethyl (C_4H_5).

The best method of obtaining ethal in a state of purity is to melt two parts of spermaceti and to gradually add to it one part of solid hydrate of potash broken up into very small pieces. The mixture should be well stirred during the operation, and when the whole of the potash has been added should be treated with water and slight excess of hydrochloric acid. The ethal and fatty acids are thus liberated, float on the surface of the aqueous liquor, and after being carefully removed by decantation are agitated with excess of hydrate of lime. A solid lime-soap is thus formed, from which the ethal may be separated by dissolving out with spirit of wine; the spirit distilled off and the residue digested in ether gives a solution from which the ethal may be obtained in a pure state by evaporation.

Ethal thus purified is a white, solid, crystalline mass. It melts when heated to 119° Fahr., and by very slow cooling is obtained in brilliant lamellar crystals. It has neither odour nor taste, is easily volatilised with vapour of water, and when pure may be distilled alone without undergoing decomposition. It is insoluble in water, but miscible in all proportions with alcohol or ether. When ethal is heated with anhydrous phosphoric acid, it is by dehydration converted into

Cetene ($C_{32}H_{32}$), a colourless oily liquid. Boiling point, 527° Fahr. Vapour density, 8·007. It may be distilled without decomposing, is insoluble in water, very soluble in alcohol or ether, has no action on test-paper, and burns with a pure white flame.

Sodium and potassium act upon hydrate of cetyl at a temperature of 212° Fahr., forming *cetylates*—

$\begin{matrix}C_{32}H_{33}\\K\end{matrix}\}O_2$ Cetylate of potash. $\qquad$ $\begin{matrix}C_{32}H_{3}\\Na\end{matrix}\}O_2$ Cetylate of soda.

The soda salt, called also *oxide of cetyl and sodium*, is a yellowish-gray solid. It melts at 212° Fahr., and at 230° Fahr. is a clear liquid. Boiling water does not affect it; hydrochloric acid decomposes it into chloride of sodium and hydrate of cetyl. When *iodide of cetyl* (produced by the reaction of iodine, phosphorus, and hydrate of cetyl) is heated with cetylate of soda, at a temperature of 230° Fahr., *oxide of cetyl* is obtained.

Oxide of cetyl ($C_{64}H_{66}O_2$) results, in the manner just indicated, by virtue of the following decomposition :—

$$\underbrace{\left.\begin{matrix}C_{32}H_{33}\\ I\end{matrix}\right\}}_{\text{Iodide of cetyl.}} + \underbrace{\left.\begin{matrix}C_{32}H_{33}\\ Na\end{matrix}\right\}O_2}_{\text{Cetylate of soda.}} = \underbrace{\left.\begin{matrix}Na\\ I\end{matrix}\right\}}_{\text{Iodide of sodium.}} + \underbrace{\left.\begin{matrix}C_{32}H_{33}\\ C_{32}H_{33}\end{matrix}\right\}O_2}_{\text{Oxide of cetyl.}}$$

The iodide of sodium may be washed out with water, and the oxide of cetyl purified by crystallisation from boiling alcohol or ether. It is a very stable substance; neither hydrochloric nor nitrohydrochloric acid affect it. It melts at about 130° Fahr., and at 572° Fahr. distils without decomposition.

Chloride of cetyl, $\left.\begin{matrix}C_{32}H_{33}\\ Cl\end{matrix}\right\}$, is an oily body, lighter than water, derived from hydrate of cetyl by reaction with perchloride of phosphorus. When chloride of cetyl is heated with an alcoholic solution of monosulphide of potassium, *cetyl-sulphydric ether*, is produced, more simply called

Sulphide of cetyl $\left(C_{64}H_{66}S_2 = \left.\begin{matrix}C_{32}H_{33}\\ C_{32}H_{33}\end{matrix}\right\}S_2\right)$, purified by washing with water and crystallisation from a mixture of alcohol and ether. It is obtained in spangles of considerable lustre. They melt at 135·5° Fahr., and solidify into a radiate mass of crystals at 129·2° Fahr.

Sulphydrate of cetyl $\left(C_{32}H_{33}S_2 = \left.\begin{matrix}C_{32}H_{33}\\ H\end{matrix}\right\}S_2\right)$, or *cetyl-sulphydric acid*, or *cetyl-mercaptan*. When alcoholic solutions of chloride of cetyl and sulphydrate of potash are mixed, sulphydrate and sulphide of cetyl are produced; the first is obtained pure by adding to the mixture acetate of lead, washing the precipitate with water, and finally digesting it in ether, when it dissolves out, and may be crystallised by evaporation. It melts at 123° Fahr., and re-solidifies at about 111° Fahr. In other respects it much resembles sulphide of cetyl.

Cetyl-sulphuric acid ($C_{32}H_{33}O$, HO, $2SO_3$), (*sulphocetic acid*). At the temperature of boiling water hydrate of cetyl combines with sulphuric acid; the mass dissolved in alcohol, and an alcoholic solution of potash added, yields sulphate of potash, which precipitates, and *cetylsulphate of potash* ($C_{32}H_{33}O$, KO, $2SO_3$), which remains in solution; by evaporation and recrystallisation it is obtained in beautiful pearly plates.

Cetyl-disulphocarbonic acid ($C_{32}H_{33}O$, HO, $2CS_2$). The potash salt of this acid, ($C_{32}H_{33}O$, KO, $2CS_2$), is obtained by adding finely powdered hydrate of potash to a saturated solution of hydrate of cetyl in bisulphide of carbon. The glue-like product dissolved in alcohol yields on evaporation flocks of *cetyldisulphocarbonate of potash*. The solution of this salt precipitates salts of mercury, silver, lead, and zinc. Hydrochloric acid sets free hydrate of cetyl.

Tri-cetylamine, $(C_{96}H_{99}N) = N\left\{\begin{matrix}C_{32}H_{33}\\ C_{32}H_{33}\\ C_{32}H_{33}\end{matrix}\right.$, obtained by the action of ammoniacal gas on iodide of cetyl at a temperature of about 356° Fahr.; iodide of ammonium precipitates and the liquid portion consists of the above base. From solution in alcohol this substance crystallises in colourless needles. Melting point, 102·2. It combines with acids to form salts, all of which are insoluble in water, but soluble in alcohol or ether.

Cetylaniline (*cetylphenylamine*), $(C_{44}H_{39}N) = N\left\{\begin{matrix}C_{32}H_{33}\\ C_{12}H_5\\ H\end{matrix}\right.$, produced by reacting with excess of aniline on iodide of cetyl. The iodide of phenyl-ammonium that results at the same time is removed by washing with a mixture of ether and water, and the cetylaniline converted into a hydrochlorate, which is decomposed with caustic potash and crystallised from boiling alcohol. Thus obtained, it occurs in plates of considerable lustre. Melting point, 107·6° Fahr.; solidifying point, 82·4° Fahr. It is insoluble in water, very soluble in alcohol or ether; it neither precipitates metallic solutions nor acts upon vegetable colours. It combines with acids to form salts, most of which are crystalline.

Dicetylaniline, $C_{76}H_{71}N = N\left\{\begin{matrix}C_{32}H_{33}\\ C_{32}H_{33}\\ C_{12}H_5\end{matrix}\right.$, is obtained by acting with one equivalent of iodide of cetyl on one equivalent of cetylaniline. It much resembles the latter body, but is more fusible.

CETYLDISULPHOCARBONIC ACID. [CETYL.]

CETYLIC ACID. [PALMITIC ACID.]

CEVADIC ACID, a peculiar acid obtained by Pelletier and Caventou from cevadilla, the seed of the *Veratrum sabadilla*. When this seed is digested in ether, a fat oil, consisting of stearine and elaine, is dissolved; the oil, separated from the ether by distillation, is then saponified by potash; this soap is decomposed by tartaric acid; the fat acids, set free, are separated by the filter; and the solution being distilled, cevadic acid, mixed with much water, is condensed in the receiver: this is saturated with baryta, and the salt obtained by evaporation to dryness is mixed with phosphoric acid and distilled. The cevadic acid sublimes in white pearly needles which fuse at 67° Fahr., and exhale the same smell as butyric acid, or as rancid butter, which owes its smell to the latter acid. Cevadic acid sublimes at a few degrees above its melting point, and it is soluble in water, alcohol, and ether. Its salts are but little known, but they retain the smell of the acid; the salt of ammonia precipitates the persalts of iron white. Cevadic acid is also probably contained in the root of white hellebore and of colchicum. Its composition is not known.

CHÆROPHYLLINE. An alkaloid of unknown composition, found in the grains of the *Chærophyllum bulbosum*.

CHAIN-CABLES. [GROUND TACKLE.]

CHAIN (in surveying) is a measuring chain of 100 links, altogether 4 poles, or 66 feet, or 22 yards in length, so that ten square chains make an acre. It is commonly called Gunter's chain, having been first used by him, and described in his treatise on the cross-staff, &c., in the following words: "We may measure the length and breadth by chains, each chain being four perches in length, and divided into a hundred links, then will the work be more easie in arithmetic. For as ten to the breadth in chains: so the length in chains to the content in acres."

The chain is of universal use in modern surveying; but care must be taken to verify its length from time to time, since the material is very extensible, and the apparatus must necessarily be roughly used. It is stated in the account of Troughton (Ast. Soc. Monthly Notice, Feb. 1836), that the chains of two surveyors, who differed in their measurement, being sent to him, one was found two inches too short, the other three inches too long.

CHAIN RULE. This is a name given to a rule of arithmetic by which when a succession of equivalents is given, the last of each being of the same kind as the first of the next, a relation of equivalence is established between numbers of the first and last kind mentioned. Thus, if three horses be worth seven cows, and ten cows be worth thirty-nine sheep, and two sheep be worth fifty-three geese, it can be found how many geese are worth, say eleven horses, or how many horses are worth a thousand geese. Such questions, and the mode still adopted of solving them, are found in the Hindu 'Lilivati,' and in the earliest European books on arithmetic and algebra. They involve a *chain* of equivalents, each link of which is joined to the preceding and following one by the same names, and the first name of the first link is the same as the second name of the last; whence the name *chain-rule*. The process applies with great practical use to questions in the arbitration of exchanges.

The process is nothing but that of composition of ratios; but it may be simply exhibited thus :—Let it be that

3 horses	are worth	7 cows,
10 cows	,,	39 sheep,
2 sheep	,,	53 geese,
How many geese	,,	11 horses?

From the first, 3×10 horses are worth 7×10 cows, which from the second, are worth $7 + 39$ sheep: hence $2 \times 3 \times 10$ horses are worth $2 \times 7 \times 39$ sheep or $53 \times 7 \times 39$ geese. Hence $2 \times 3 \times 10 \times 11$ horses are worth $53 \times 7 \times 39 \times 11$ geese, or 11 horses are worth $53 \times 7 \times 39 \times 11 \div 2 \times 3 \times 10$ geese. By such reasoning the following rule is established :—divide the product of the numbers in the column which has not vacancy by the product of the numbers in the column which has a vacancy for the unknown quantity, and the quotient is the number with which the vacancy is to be filled up.

It is obvious that any multiplier which exists in both columns may be struck out before commencing the process: this is the peculiar advantage of the rule, namely, that it points out at once all the simplifications which can be introduced by division.

The common rule of three, and various other rules, may be brought under the chain-rule; but an attempt is sometimes made to reduce under it every question the answer to which is found by dividing one product by another. This has been done in all times, from that of the Lilivati to the present. For example, if seven men can reap three acres in ten days, how long will it take thirteen men to reap nineteen acres? The answer is found no doubt by dividing $7 \times 19 \times 10$ by 13×3; but if we attempt to put these down in the chain form we have—

10 days	3 acres
19 acres	13 men
7 men	? days.

Now even if we grant that ten days are, in the first clause, an equivalent for (being the time of reaping) three acres, and that nineteen acres are in the second clause an equivalent for (or the work of) thirteen men: we still find it impossible to make out in what sense the seven men of the first clause are an equivalent to the unknown number of days in the second. But in truth the ten days in the first clause are not absolutely and independently the time of doing the three acres, but only on condition that seven men are employed; while in the second clause the thirteen men are only the reapers of nineteen acres on the supposition of some one definite but unknown time being allowed. The question is not therefore of the same class as that which was first proposed, in which each quantity mentioned

was absolutely and unconditionally an equivalent in value to oneof the others.

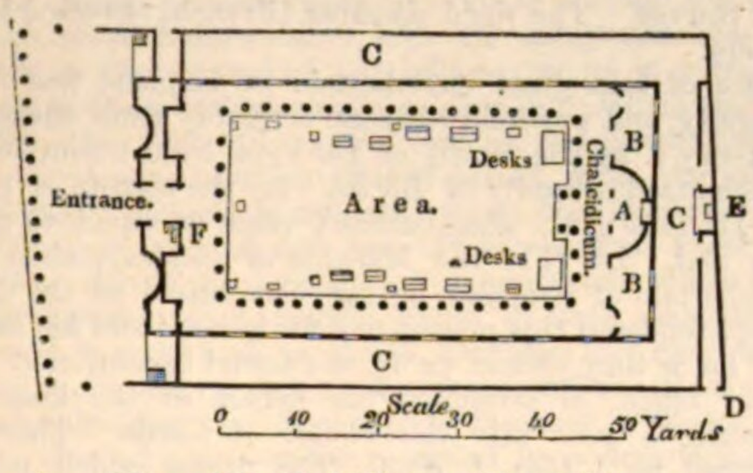
CHAIN SHOT. Two iron balls linked together by a chain eight or ten inches long are so called. They were formerly used on board ship.

CHALCI'DICUM, an apartment separated by a partition from the body of a basilica or other large building. The name, Festus says, is derived from the city Chalcis. Vitruvius (v. i.) directs that chalcidica should be constructed at the ends of a basilica, if the area is disproportionately long. [BASILICA.] A building has been discovered in Pompeii which appears to be a chalcidicum from the inscription :—

Eumachia. L. F. Sacerd. Public. Nomine. Suo. Et.
M. Numistri. Frontonis. Fili. Chalcidicum.

Cryptam. Porticum. Concordiæ. Augustæ.
Pietati. Sua. Pequnia. Fecit. Eademque.
Dedicavit.

The chalcidicum is, in this instance, considered to be an inclosed space or vestibule at the end of the open area of the building, in the centre of which space a large semicircular recess has been formed. The entire structure, at Pompeii, consists of a large area, about 130 feet by 65, surrounded by a double gallery, and has in front a pseudo-dipteral portico of eighteen columns elevated on pedestals. Under the centre of the portico was the great public entrance, was closed with folding doors, turning in sockets of bronze, and secured by bolts. On each side of the entrance there are two large circular recesses, and beyond these again are raised platforms, the staircases to which still remain. By a reference to the annexed plan, the large area of this building will be seen, with the solid desks or places for exhibiting goods, possibly cloth, for sale. The area was surrounded with a beautiful marble colonnade. Under the colonnade, at the end opposite the entrance, is the large recess (A), with offices (B) adjoining, which is considered to be the chalcidicum, and possibly was



[Plan of the Chalcidicum at Pompeii.]

a commercial tribunal, or perhaps a place for ratifying mercantile contracts, &c. Behind the colonnade is a gallery called crypto-porticus (C), either for winter use or a depositary for goods. At the back of the chalcidicum there is a passage entrance (D) leading into the crypto-porticus; and near this entrance into the crypto-porticus is a statue (E) of a certain Eumachia, erected by the *fullones* (cloth-scourers) of Pompeii to her memory. It is not improbable that there was a double gallery over the colonnade and crypto-porticus, from the circumstance of a staircase at E.

The term chalcidicum appears sometimes to have been applied to a sort of large porch attached to the entrance of a building; sometimes to a chamber or chambers by the tribune reserved for the use of the judges; but the specific use of the term is by no means certain. The word occurs on the Monumentum Ancyranum, in connection with Curia and Templum.

CHALDRON, an old measure, containing thirty-six heaped bushels. The word appears to come from *caldarium;* in French *chaudron,* or *chaudrière.* Richelet observes that brewers, sugar-refiners, dyers, &c., make use of the *chaudrière.* Its proper signification, of a large metal vessel, or boiler, was probably transferred among us to denote a large measure of capacity. It was chiefly used in the sale of coals which by an act 5 & 6 Wm. IV. c. 63, are now sold by weight.

CHALK (in Geology), a rock which forms the higher part of a series or group termed cretaceous.

Chalk is composed of nearly 44 parts of carbonic acid and 56 of lime. It is extensively used in agriculture to improve various soils. The best land for the growth of wheat contains a certain portion of argillaceous, siliceous, and calcareous earth; and when this last is deficient, the addition of chalk improves the soil more than any quantity of animal or vegetable manure could do alone. Lime produces a greater effect by its caustic nature; but as it is always put on the land in much smaller quantities than chalk, it does not so permanently improve it. Good chalk should be firm and compact, should break readily, and crumble into a fine powder; it should readily absorb moisture, and when the lumps are exposed to frost after having been wet, they should break into minute square fragments. Chalk is called a manure, and it is so, in as far as everything which increases the crop may be so called; but it is a great mistake to suppose that it may be substituted for animal and vegetable manures. Chalk may so far supersede dung that where it is used a portion of the latter may be dispensed with; but its chief use is to improve the texture of the soil, and render it better adapted to receive and retain moisture, so that a smaller portion of dung will have a greater effect than a larger would without it. No good agriculturist will trust to chalk alone on poor exhausted land, although he may do so where the soil is full of nutritive matter. In this last case however lime would be much more effectual; but chalk will make dung work well, and hence it is most frequently mixed into a compost with it, or alternate heaps of dung and chalk are put upon the land and mixed in the spreading. When chalk is used, it is of great importance to ascertain whether the natural soil contains more or less of calcareous matter. The less of this matter is found in it on analysis, the greater improvement is produced by chalk; hence the common saying, that "the farther you are from a chalk-pit, the more valuable is the chalk."

The soils most improved by it are the strong wet clays, which contain a portion of iron. Chalk acts as an absorbent, corrects astringency, and prevents, by its interposition between the particles of clay, that running into a solid mass, which is so detrimental to the roots of plants by entirely excluding atmospheric air. On loose sands its effect is different; there it acts chiefly as a cement, and the more argillaceous it is, the better it binds the siliceous particles. For light soils marl is preferable, especially when a considerable coat can be put on the land. The clay which is so abundantly used in some parts of Norfolk, and is found in many places at a small depth below the surface, owes much of its virtue to the calcareous matter which it contains, and where this is deficient, it will not much improve the soil until chalk or lime be added. Chalk is used wherever it can be procured within a moderate distance, and the soil is stiff; as in the counties of Essex, Suffolk, Berkshire, Middlesex, Buckinghamshire, and many others. In those districts where chalk is much used, it is generally put on the land in autumn, and not ploughed in till it has been exposed to the frost; or it is laid in long heaps on a headland, or by the side of a road or lane, and there turned over and mixed with the earth on which the heaps are laid. If it be exposed to the sun in summer, it must be carefully covered with earth, or it will harden so much by drying that it will be very difficult to pulverise it afterwards, and the frost will not have the same effect upon it. Ten tumbril loads of chalk, and as many of good farm-yard dung, are a very good dressing either on a fallow for wheat or previous to sowing turnips. When chalk is laid on permanent meadows, it promotes the growth of white clover; but except the meadows are wet and produce rushes, it is of no very great benefit to the grass, although it shows its effect when the grass is broken up. When land is cultivated according to the convertible system, the best time to put chalk on the land is when it is about to be ploughed up. If the grass is fed off the last year, the chalk may be put on during the preceding winter, and simply spread over the grass; it will thus be pulverised by the frost, will sweeten the pasture, and its full effect will be perceived in the first grain-crop after the land is ploughed up. When chalk has been some time on the land, it is gradually carried below the soil by the filtration of the surface-water, and by the action of earthworms, which are continually carrying upwards and depositing on the surface the fine earth removed from below the chalk dressing. After a few years therefore it requires to be renewed, which shows the advantage of putting on a moderate quantity and repeating it in six or seven years, in preference to putting on a large quantity at once, unless where lands are reclaimed from a state of waste, and require to be improved by a large admixture of calcareous matter before they can be made productive by enriching manures. This is the case with those yellow loams which contain much iron, and which are generally found under the *iron pan,* so well-known to all those who improve poor light heath-land. [BARREN LAND.] The quality and effects of chalk as a dressing depend, not only on the deficiencies of the soil to which it may be applied, but also on its own varying composition, and that chalk is best, which is found to contain the largest per centage of phosphate of lime in addition to the calcareous and clayey parts of which it mainly consists.

An important use of chalk is to form ponds in porous soils for the use of cattle. A stratum of chalk a few inches thick, protected by a coat of gravel and sand to prevent its being trod through, will effectually retain the water; and if a considerable proportion of salt is beat up with it and intimately mixed, it will effectually prevent worms from making lodgments in it, and keep in water for a very long time. It is of advantage to throw chalk into all ponds used by cattle; it corrects any acidity which may arise from stagnation, and the water in which chalk is diffused, is more wholesome than that which contains clay alone. In fattening calves chalk is of the greatest use; it may be laid in the calf-pens for them to lick, which they will readily do, or it may be scraped and mixed with a small quantity of salt, and laid in a small manger within the reach of each calf. It effectually prevents scouring, and keeps their digestion in a proper state.

In many parts of England the whole sub-soil to a great depth is a solid mass of chalk, and the earth which covers it contains very little else than carbonate of lime, with a small portion of vegetable matter in a decomposed state. In this soil a short sweet herbage grows, which is extremely grateful to sheep; according the chalky hills, called downs, in Sussex, Wiltshire, &c., are chiefly devoted to sheep-pasture. Along the sides of these hills, where the waters continually accumulate the finer particles of the soil which are washed down from above,

some very productive arable lands are formed, and very good crops of barley are raised. There is a plant which seems to delight in chalky soils, and to flourish better there than in deeper and richer earth. This is the saintfoin (*Hedysarum Onobrichis*), and its introduction among the cultivated grasses has greatly raised the value of chalky land, previously considered too poor to repay cultivation. It not only produces an excellent fodder, superior to meadow-hay and scarcely inferior to clover; but by its roots it so divides and enriches the soil, that after having covered it with luxuriant crops of hay for several years, it leaves it in a fit state to produce excellent crops of grain, with very moderate manuring,

Chalky soils are not subject to the same perennial weeds which infest richer lands; couch-grass is seldom found in chalk, but the annuals, such as May-weed, charlock, poppy, crow-foot, and several others, abound in it. When a chalky soil produces thistles, it is an indication of its containing a portion of argillaceous earth, which improves its fertility.

CHALK FORMATION, in Nat. Hist. Div.

CHALLENGE. [Jury.]

CHALYBEATE SPRINGS. Of all mineral waters those containing iron are the most common; but such only are considered chalybeates, in a medical sense, in which the iron predominates, if not in quantity, at least in action, over the other ingredients. The quantity and combinations of the iron vary in every spring; but it is generally combined with carbonic acid, in the form of protoxide or protocarbonate, and is deposited in considerable quantity in the form of oxide, when the water reaches the external air. The presence of chalybeate springs may generally be detected by the appearance of the stream or water-course. The inky or styptic taste of the water also indicates the presence of iron. In other instances it is combined with sulphuric acid, in the form of sulphate of iron; it is often associated with alumina; and more rarely hydrochloric acid is combined with it. When a large proportion of free carbonic acid is present, such springs are termed *acidulo-chalybeate*.

The temperature rarely exceeds that of the ordinary temperature of spring water, and it is generally lower. Of the former class several exist on the Continent; Bath is the only example in Britain. Cold chalybeate waters, with proper conveniences for their employment, are not very numerous in Britain. Tunbridge, Harrowgate, and Holywell, in England and Wales; and Peterhead, Dunblane, and Bonnington near Edinburgh, in Scotland, are the chief. Chalybeate waters may be employed either internally or externally in the form of baths; the former mode is the most common in this country. The use of chalybeate waters possesses many advantages over the other modes of administering iron, and not only enables many to employ this metal, but likewise to persevere with it for a much longer time. This is more particularly the case when much free carbonic acid exists in the water, as in the acidulo-chalybeate springs. The cold temperature of the water certainly disagrees with many persons, but this may be obviated, either by beginning with the Bath waters, or pouring the quantity intended to be used into a little warm water, or adding a tea-spoonful of the compound tincture of cardamoms to the first glass. The persons who require chalybeate waters are those who need tonics to improve their constitution and remove a tendency to disease; or convalescents from acute disease; or persons who have been debilitated either by a residence in warm climates or by severe mental exertions. Persons of a plethoric habit can rarely use them without undergoing some preparatory treatment. Like iron, they are improper during pregnancy, or the course of an inflammatory disease, or the existence of organic affections of the heart or liver, or tendency to apoplexy. When alone, or still more when combined with alumina, they often cause constipation, which requires to be obviated: in some individuals, especially at the commencement of their use, an opposite state occurs: in either case a black colour of the motions is observed, which should excite no alarm, as it simply arises from the tannin of the food uniting with the iron, and forming a black tannate of iron. During the use of chalybeate waters, the diet of the patient requires careful regulation.

The acidulous and carbonated chalybeate waters do not bear transportation well; the waters which contain sulphate of iron may be sent to a distance with less injury to their qualities. Two methods have been proposed to prevent the deterioration of the acidulous and chalybeate waters during removal to a distance; the one by boiling the corks previous to putting them into the bottles; the other by merely driving an iron nail through the cork, so as to be in contact with the water, which latter method is even said to increase the quantity of iron held in solution by the water.

Baths of chalybeate water are sometimes used along with the internal employment of the waters, sometimes alone. They afford great assistance in the cure of diseases for which iron is proper, and can sometimes be employed when the internal use of iron is impracticable. Those of this country are less resorted to than Alexisbad in the Harz, or those of Nassau. [Iron; Bathing.] Gairdner 'On Mineral and Thermal Springs.'

CHAMÆLEON, a constellation near the South Pole, formed by Bayer. It contains no stars of conspicuous magnitude.

CHAMBER, a recess formed at the lower extremity of the bore of a gun, howitzer, or mortar, and in the direction of the axis, in order to receive the charge of powder by which the shot or shell is to be projected. Chambers are made of various forms, the Gomer, the pear-shaped, the cylindrical, the hemispherical, and the Paixhan; the magnitude of the chamber is such as to allow it to contain the quantity of powder constituting the charge, but its diameter is less than that of the bore. It is used in guns in which the charge of powder being small in comparison to the size of the bore, great loss of power would ensue from the explosion of the powder, in the empty space below the shot and breach, unless the bore were contracted to be nearly filled with the powder.

The Gomer chamber, so called from the name of the inventor, is made in the form of a frustum of a cone, terminating with a concave hemisphere at the smaller parts, which is the extremity of the chamber, and the greater circumference coinciding with that of the bore. The shot or shell, being placed in close contact with the conical part of a chamber of this kind, thus becomes subject to the whole force of the elastic fluid.

The Gomer chamber is the best when the charges are large, and the cylindrical when they are very small.

CHAMBERLAIN (*custos cubiculi*, or *cubicularius*, keeper of the chamber). Cubicularius was the Roman name for a slave whose special business was to look after the rooms or chambers in the house, introduce visitors, and the like. The cubicularius was thus a confidential slave or freedman, as the case might be, and a kind of guardian of his master's person. Under the emperors the cubicularii were officers in the imperial household; and were called the "cubicularii sacri cubiculi," the chamberlains of the imperial chamber. ('Cod.' xii. tit. 5.) The emperor's wife, the Augusta, also had her chamberlains. This office, like many others in royal households, is derived from the usages of the later Roman Empire. In the Anglo-Saxon times, in England, the chamberlain appears to have had the name of Camerarius, and had the keeping of the king's treasure (Ealred, in 'Vit. S. Edw. Confess.,' c. ii. p. 9), by which name this officer also occurs in the Domesday Survey. The word chamber (French, *chambre*) is from the Latin camera.

The office of lord great chamberlain of England was once of the highest dignity, and was held in grand serjeanty from the second year of King Henry I. by the family of De Vere, from whom it passed, by a female heir, to the family of Bertie. By the statute of precedency, 31 Hen. VIII., the great chamberlain's place was next to that of the lord privy seal. In 1714 the Marquis of Lindsay, then hereditary great chamberlain of England, having been raised to the dukedom of Ancaster, surrendered this precedency for himself and his heirs, except only when he or they should be in the actual execution of the duties of the said office, in attending the person of the king or queen, or introducing a peer into the House of Lords. This surrender was confirmed by 1 Geo. I. c. 3. The duties which now devolve upon the great chamberlain are, the dressing and attending on the king at his coronation; the care of the Palace of Westminster; the provision of furniture for the Houses of Parliament, and for Westminster Hall, when used on great occasions; and attendance upon peers at their creation, and upon bishops when they perform their homage. On the death of Robert, the last duke of Ancaster but one, in 1779, the office of hereditary great chamberlain descended to his two sisters, Priscilla, Lady Willoughby de Eresby, and Georgiana Charlotte, Marchioness Cholmondeley. The office is now jointly held by the families of Cholmondeley and Willoughby de Eresby, and the honours are enjoyed in each alternate reign by each family successively.

The office of lord chamberlain of the king's household is changed with the administration. He has the control of all parts of the household (except the ladies of the queen's bed-chamber) which are not under the direction of the lord steward, the groom of the stole, or the master of the horse; the king's chaplains, physicians, surgeons, &c., as well as the royal tradesmen, are by his appointment; the companies of actors at the royal theatres, as part of the household, are under his regulation, and he is also the licenser of plays. [Censorship of the Press.] One of the officers in his department is styled Examiner of Plays.

The chamberlain of the corporation of the city of London is an officer elected by the freemen who are liverymen. By an act of common council of 5 Henry IV. the office is an annual one, but it is very rarely that the existing officer is not re-elected. There has been no such opposition since 1778. The duties of the chamberlain are judicial and administrative. He admits on oath all persons entitled to the freedom of the city, and hears and determines all matters of complaint between masters and apprentices, and may commit either. He may discharge the apprentice from his indentures, and a part of the premium may be recovered by a peculiar process in the Lord Mayor's court. An appeal is said to lie from the decision of the chamberlain to the lord mayor. The chamberlain has the conservation of lands, moneys, or goods of citizens who die intestate, leaving orphans, on the application of such orphans or others on their behalf, for which purpose the chamberlain is deemed in law a corporation sole; but such applications are now rarely made. As treasurer of the corporation, he has to receive all rents, profits, and revenues of markets and other items of receipt forming the income of the corporation, and to pay all money on account of the corporation upon competent warrants or orders. The fixed annual income of the chamberlain is 1160*l.* 9*s.* 4*d.*:

his "ancient bill of fees" is 94*l.* 4*s.* a-year. He obtains an annual profit of from 1000*l.* to 2000*l.* from balances of the corporation money retained in his hands. This principle of remunerating a public officer having been objected to by the Commissioners of Corporation Inquiry ('Second Report,' p. 102), a new system is about (1859) to be introduced.

In the Exchequer Court of the County Palatine of Chester there is a chamberlain, an office generally held by some nobleman; and there is also a vice-chamberlain.

There was an officer called the chamberlain in two hundred and three of the municipal corporations investigated in 1834 by the Commissioners of Corporation Inquiry.

CHAMELION MINERAL. [MANGANESE—*Manganic Acid.*]

CHAMPAGNE WINE. [WINE.]

CHANCE. This word has been used in two senses, as opposed to Providence, and as opposed to certainty. For the theory of chances, in the latter sense, see PROBABILITIES, THEORY OF.

CHANCE-MEDLEY, in English law, is a singular corruption of *chaudemellé*, a term well known in old French legal phraseology, and in the barbarous Latin of ancient ordinances translated *calida melleia*. The term in French law denoted, consistently with its etymology, a casual affray or broil, accompanied with heat or violence, but without deliberation or preconceived malice. (Ducange, 'Gloss.' Meslie.) In English law, it can hardly be doubted that chance-medley originally meant the same thing; but in modern times the expression is limited to a particular kind of homicide, namely, the killing another in self-defence upon a sudden and unpremeditated encounter. There is often much difficulty in distinguishing homicide by chance-medley, which, though an offence by law, is excusable on the ground of self-defence, from the crime of manslaughter. The general distinction is, that if both parties are actually fighting, he who gives the mortal stroke is guilty of manslaughter; but if one of them at first refuses to fight, and on being closely pressed, retreats as far as he can, and at last, in order to avoid his own destruction, kills his antagonist, this is homicide excusable on the ground of self-defence; or, as it is inaccurately called, chance-medley. (Foster's *Crown Law*, tit. 'Homicide.')

CHANCEL, that part of a church east of, or beyond, the nave, in which the communion table or altar is placed, with the area before it, in which the congregation assemble when the Eucharist is administered. This part of a church was often separated from the nave or body of the church by lattice work, *cancelli*, and it was from this circumstance that the term chancel seems to have originated. The use of the term is restricted to parish churches and churches which have no great choir, and no aisle or chapels around the choir or chancel. The great arch dividing the chancel from the nave in Gothic churches is called the chancel arch—and is regarded by ecclesiological writers as symbolising the gate of heaven.

In some churches we may hear of the chancel of a particular family. This is in cases in which some particular family has had a private oratory within the church, which has usually been also the burial place of the family. These private chapels or chantries are sometimes called chancels, for the same reason that the great choir is sometimes so called; that is, in consequence of being divided from the rest of the church by *cancelli*.

CHANCELLOR (in Latin, *Cancellárius*). The primary meaning of cancellarius is "qui ad cancellos assistit," one who is stationed at the lattice-work of a window or a doorway, to introduce visitors, &c. A cancellarius in this sense was no more than a door-keeper. The emperor Carinus made one of his cancellarii prefect of the city, a promotion which caused great dissatisfaction. (Vopiscus, 'Carinus.') In another sense, cancellarius was a kind of legal scribe, so called also from his position at the cancelli of the courts of law. The cancellarius, under the later emperors, and in the Constantinopolitan court, was a chief scribe or secretary (ὁ μέγας λογοθέτης), who was ultimately invested with judicial powers, and a general superintendency over the rest of the officers of the emperor. He was called cancellarius because he sat *intra cancellos* (within the lattice), a screen dividing off a portion of a larger room for the sake of greater privacy; from which circumstance the chancel of a church also acquires its name.

The prelates of the Roman church had likewise an officer so called; in the Church of England, each bishop has a chancellor, to whom are entrusted judicial functions. All the modern nations of Europe had a chancellor, though his powers and duties seem to have varied in each.

In England the chancellor was originally the king's chief secretary, to whom petitions were referred, by whom patents and grants from the crown were approved and completed, and by whom reports upon such matters were, if necessary, made to the king; hence he was sometimes styled Referendarius. This term occurs in a charter of Ethelbert, A.D. 605; and Selden considers it synonymous with chancellor, a name which, he says, first occurs, in the history of England, in the time of Edward the Elder, about 920.

In the capacity of secretary he was the adviser of his master; prepared and made out his mandates, grants, and charters, and finally (when seals came into use) affixed his seal. Hence, or perhaps because in early times he was usually an ecclesiastic, he became keeper of the king's conscience, examiner of his patents, the officer by whom prerogative writs were prepared, and keeper of the great seal. The

last ecclesiastic who exercised the office was John Williams, archbishop of York, who was lord keeper from July 10, 1621, to November 1, 1625; his friend and secretary, John Hacket, who became bishop of Lichfield and Coventry, wrote his life in a volume of singular interest, which he entitled 'Scrinia Reserata.'

In early times, and before the precise limits and extent of the jurisdiction of the different courts of justice were clearly defined, the special interference of the crown, as the fountain of justice, was frequently sought against the decisions of the courts of law; as well as in matters which were not cognisable in the ordinary courts, or in which, from the maintenance or protection afforded to his adversary, the petitioner was unable to obtain redress. The jurisdiction with which the modern chancellor is invested, thus had its origin in that discretionary power, that ultimate jurisdiction to administer justice, which remained in the crown on the establishment of courts of justice with properly defined authority; therefore, although the exercise of those powers in modern times is scarcely, if at all, less circumscribed and hemmed in by rule and precedent than the strict jurisdiction of the courts of law, controversies have occasionally arisen as to the powers of the chancellor, the most celebrated being that between Sir Edmund Coke and Lord Chancellor Ellesmere.

The style of this officer in England is, since the union with Scotland, Lord High Chancellor of Great Britain. He takes rank above all dukes not of the blood royal, and next to the archbishop of Canterbury. He is appointed by the delivery of the great seal into his custody, and the resumption of the great seal by the sovereign determines his office. By virtue of his office he is the principal adviser of the crown in matters of law, and a privy counsellor, speaker and prolocutor of the House of Lords, chief judge in the court of chancery, and the head of the profession of the law; visitor in right of the crown of all hospitals and colleges of royal foundation; and patron of all crown livings under the value of 20*l.* a year, according to the valuation made in the reign of Henry VIII., and confirmed in that of Elizabeth. He appoints nearly all the judges of the superior courts (the prime minister of the day nominating the two chief justices), the commissioners in bankruptcy, and the judges of the county courts. He also appoints and removes all justices of the peace, though usually only at the recommendation of lords-lieutenant of counties. He issues writs for summoning parliaments, and transacts all business connected with the custody and use of the great seal. He is a conservator of the peace, and may award precepts and take recognisances to keep the peace; and has concurrent jurisdiction with the other judges of the superior courts, with respect to writs of habeas corpus. Except in the case of service of process, given to him by some recent statutes, the lord chancellor has no jurisdiction in Scotland.

The authority of lord chancellor and lord keeper are made the same by the Stat. 5 Eliz. c. 18, though it is not now customary to appoint a lord keeper. The last lord keeper was Lord Henley, in 1757. The great seal is, however, sometimes put into commission during the temporary vacancy of the office or the sickness of the chancellor, the seal being entrusted to the chief commissioner.

The chancellor is not only a judicial officer of the crown, but he has important political functions; he has a seat in the cabinet, and usually takes an active part in public measures. He resigns office with the party to which he is attached. The inconvenience and necessary delay arising from his removal during the pendency of suits in his own court and before the House of Lords, and the arrear of business caused by the variety of duties which he is called upon to perform, have suggested the necessity of some alteration in the constitution of the office. Many expedients have been tried: vice-chancellors have been appointed; the master of the rolls has been empowered to assist in the usual and ordinary functions of the court of chancery; a court of appeal in chancery has been constituted; and a number of useful and important reforms have been made in the subordinate offices of the court. But such is the pressure of business on this great officer, that all these means have been ineffectual to remedy the inconvenience of so many important duties being devolved on one individual. Various propositions for the creation of a ministry of justice have been made; and it is not improbable that, before long, material alterations in the nature and duties of this great office will be effected.

By the Stat. 3 & 4 Will. IV. c. 111, in consideration that the chancellor had lost the patronage of certain offices then abolished, the crown is empowered to grant an annuity of 5000*l.* a year to the lord chancellor or lord keeper on his resignation of office. There is also a lord high chancellor of Ireland, whose authority within his own jurisdiction is in most respects the same as that of the lord high chancellor of Great Britain. (Selden, 'Off. Ch.;' Blackst. 'Comm.;' Story 'on Equity Jurisprudence.')

The *Chancellor of a Church or of a Bishop* is vicar-general to the bishop, holds his courts, and directs and assists him in matters of ecclesiastical law. He has a freehold in his office, and he is not necessarily an ecclesiastic; but if he is a layman, or married, he must be a doctor of the civil law. (Blackst. 'Comm.,' 37 H. VIII. c. 17.)

The *Chancellor of a Cathedral* is an officer who superintends the regularity of the religious services.

The *Chancellor of the Duchy of Lancaster* presides either in person or by deputy in the court of the duchy of Lancaster, concerning all matters of equity relating to lands holden of the king, in right of the

duchy of Lancaster. The court is held four times a year by the Vice-Chancellor at Liverpool.

The *Chancellors of the Universities of Oxford and Cambridge* are elected by the respective corporate bodies of which they are the heads; they exercise exclusive jurisdiction in all civil actions and suits where a member of the university or privileged person is one of the parties, except in cases where the right to freehold is concerned. In both the English universities the duties of the chancellor are in nearly all cases discharged by a vice-chancellor.

The *Chancellor of the Exchequer* is under-treasurer, and holds the seal of the exchequer. The office of lord high treasurer is now executed by the lords commissioners of the treasury. The chancellor of the exchequer is the principal finance minister of the crown, and the office is generally held by the prime minister when he is a member of the House of Commons. The legal functions of the chancellor of the exchequer are now merely formal. Bills in the exchequer are addressed to him and to the barons of that court, and on some occasions (as on his appointment) he sits in court; but all the legal business is transacted by the barons. If the chief baron and barons are equally divided in opinion, the chancellor of the exchequer may be required to rehear the cause with the barons, and give his decision. The last instance occurred in 1735, when Sir Robert Walpole gave his decision upon a question of considerable doubt and difficulty which is said to have given great satisfaction. (Fowler's 'Exchequer Practice.')

The *Chancellor of the Order of the Garter*, and other orders of knighthood, seals and authenticates the formal instruments of the chapter, and keeps the register of the order. He exercises various functions at the installation of the knights, and during their meetings and processions.

CHANCELLOR OF SCOTLAND. As in England, the chancellor of Scotland was always a high officer of the crown, and had great influence with the king and authority in his councils. As in England too, that authority at length extended itself beyond its former limits, and affected the whole judicial power of the kingdom. Its operation and effect in the two countries, however, was different: for while in England the chancellor only carved out for himself a jurisdiction in equity, in Scotland he reached the head of the administration of justice, and sat in a court which dispensed both equity and common law, and the course of proceeding in which all the other judicatures of the realm were bound to follow.

In 1425, shortly after the return of James I. from his long captivity in England, the "chancellor and with him certaine discreete persones of the thre estates chosen and depute by the king" were erected into the court of the session, for the final determination of all matters competent to the king and his council. This court however expired with Bishop Wardlaw, from whom in all likelihood it originated; and the former policy of determining suits by the old common law was restored. This continued (with the exception of an attempt to the contrary in 1457, probably under the influence of Bishop Shorsewood, the favourite and confessor of King James II.) till the time of Bishop Elphinstone, to whom undoubtedly may be ascribed the crafty acts passed in 1487 for the recovery of the large jurisdiction of the chancellor and court of the session, as well as the act 1494, c. 5, to enforce in the courts the study and practice of the canon and civil laws. Nor perhaps shall we greatly err in conceiving his zeal to have been employed in establishing in 1503 the court of daily council, which was essentially a restoration of the old court of the session. But all these proved only preparatory steps to the erection of the court of council and session, or college of justice, which was instituted in 1532, and has continued to our own time. Of this college the chancellor, or, as he then began to be styled, lord chancellor of Scotland, was to be principal; and as on the one hand it was the supreme court of the kingdom, and on the other all inferior courts were required to copy its proceedings, it wielded the whole judicative power of the country. It early claimed also, and exercised, a large legislative power under the statutes permitting it to pass acts of sederunt; and the officers who executed its warrants and decrees, were either its own macers or else messengers, over whom it obtained complete control. These powers the court wielded so as to effect nearly an entire change of the law. The ecclesiastical estate for some time predominated both on the bench and at the bar. The consequence was, the canon and civil laws became, what indeed they used to be styled, the common law of the land, and the old common law became antiquated, and ultimately obsolete. The new system was too effectually established to be much disturbed by the Reformation; and the union with England, where the old common law had been and has ever continued the antagonist of Roman jurisprudence, has accordingly not produced any assimilation of the laws of the two countries. At the Reformation the authority, though not the spirit, of the canon law may be considered, in matters ecclesiastical at least, to have ceased; and not long afterwards ministers of the Gospel were disabled by statute from being either of the bench or bar. Since the union, when both portions of the island became one great mercantile community, various provisions have been made to improve and assimilate the laws of the two kingdoms; but these have been confined to that one branch of jurisprudence, and an apparently invincible repugnance has been evinced to more extensive changes.

The procedure in the court of session in Scotland resembles in some points that of the court of chancery in England. Both courts indeed, and the ecclesiastical courts of both countries, borrowed their forms from the court of Rome, and with these last the forms of the court of session in many respects still agree. The bill or written supplication to the court for letters, whether of summons or of diligence, is of the same nature with the supplication for letters in the court of Rome: and it is observable that when the desire of the bill is granted, it is in the same terms in both courts. The condescendence and answers are plainly derived from the articuli and responsiones of the papal tribunal. The initialia testimonii, or purging of a witness, are identical with the interrogatoria generalia of that court. Letters of advocation, suspension, and reduction, are well known there. The "malè appellatum et benè processum" is but verbally translated in the phrase of the Scots court, "Finds the letters orderly proceeded;" and letters of horning, caption, and relaxation, bear their papal origin impressed upon them. It appears also that from an early period the court issued commissions to its macers to perform judicial duties, as the ecclesiastics appoint the inferior church officers their legates and commissaries for the like purposes; and at an early time also the judges began the yet subsisting custom of changing their name on their elevation to the bench, in imitation, as it seems, of the like custom on elevation in the papal hierarchy.

From what is above stated, we may see why there is no court of chancery in Scotland, separate from the courts of common law, as in England; the whole judicatures of Scotland having become subject to the court of session, where the chancellor presided, dispensing what has been described as both equity and common law. But from the earliest times there has been a chancery in Scotland, and many of the early chancellors are described as "clerici cancellarii."

A list of the chancellors as of the other great officers of the crown in early times, is given in Crawford's 'Officers of State.' A subsequent list is given by Chalmers in his 'Caledonia;' but a correct or complete list has not yet, it is believed, been compiled; and except to the Scottish antiquary the matter is not one of any great interest. The earliest chancellor whose existence can be authenticated, was Constantine, earl of Fife, chancellor, temp. Alex. I. Alan St. Edmonds, bishop of Caithness in 1291, seems to be the only chancellor nominated by King Edward I. of England, who associated in office with him Walter de Agmodescham (Ayloff's 'Cal.' 105), and thereafter Adam de Bodingdon, who was vice-chancellor, 1291 (with half a mark a day for his salary, Rotul. 'Scot.' 9), and chancellor in December of the same year, the bishop of Caithness having previously died. He was followed by nearly thirty ecclesiastical chancellors, till, in 1460, Andrew, Lord Avendale, held the office. After three episcopal chancellorships, Colin, earl of Argyll, held office in 1483 to 1488; and after him came Archibald, earl of Angus, and George, earl of Huntley. James Beaton, abbot of Dunfermline, became chancellor in 1513. In 1525, on the removal of the duke of Albany from the regency, the earl of Angus turned Beaton, now bishop of St. Andrews, out of the chancellorate, which with several other offices he then engrossed to himself. On Angus's fall the place was given, in 1528, to Gavin Dunbar, archbishop of Glasgow, in whose time the college of justice was instituted.

The series of chancellors need not be further continued. By the treaty of Union it was provided that there should in future be but one great seal for the United Kingdom, and that a seal should be kept and used in Scotland for such private rights or grants as had usually passed the great seal of Scotland. The office of chancellor of Scotland then properly expired, and none have been appointed to it since the earl of Seafield, who was chancellor at the time of the Union.

CHANCERY (*Cancellaria*); the term is derived from Chancellor, *Cancellarius*, and signifies the court where that judge exercises his functions. There are several chanceries, as there are several chancellors; but the place where the Lord High Chancellor's judicial functions are exercised is especially called the Chancery.

The principal part of the business of the Court of Chancery consists in the administration of *equity*, a name which in this country comprehends a particular set of rules, having the force of law, which are applicable to such matters as belong to the jurisdiction of the court. [EQUITY.] The court of chancery of the County Palatine of Lancaster, the court of the Stannaries, the Lord Mayor's court of London, and various local courts have a similar jurisdiction.

The Lord Chancellor, the Lords Justices of the Court of Appeal in Chancery, the Vice-chancellors, and the Master of the Rolls are the judges by whom equity is administered in Chancery. Each of these judges has a separate court. These courts have no fixed or permanent situation; but except on the first day of term, when they meet at Westminster, the former are held in Lincoln's Inn, and the last at the Rolls, in Chancery-lane.

The Court of Chancery is a name which properly belongs to the Lord Chancellor's court, and the court of the Lords Justices and Vice-Chancellors. The Master of the Rolls, who is appointed by the crown by letters patent, and holds his office for life, administers equity in a separate court, called the Rolls. He has the power of hearing and determining originally the same matters as the lord chancellor, excepting cases in lunacy, which are specially delegated by the crown to the chancellor and lords justices. All orders and decrees pronounced by the Master of the Rolls must be signed by the Lord Chancellor before they are enrolled. This officer has precedence next to the lord

chief justice of the Queen's Bench. The office is one of high antiquity, and the salary is 6000*l.* a year. The Master of the Rolls has very considerable patronage, connected principally with the public records, of which he is the keeper.

The Court of Appeal in Chancery was created by the statute 14 & 15 Vict. c. 83, to exercise primarily the same appellate jurisdiction as the lord high chancellor, that is to say, to hear and determine appeals from the decrees of the vice-chancellors and master of the rolls. The two judges (who are called lords justices, and have precedence after the master of the rolls) sitting together, or with the chancellor, constitute this court of appeal; but, like the lord chancellor, they may take and dispose of original causes. The lords justices receive from the crown the same authority on matters of lunacy as the chancellor, and they, sitting together without the chancellor, constitute the Court of Appeal in bankruptcy.

The office of Vice-Chancellor was first created by stat. 53 Geo. III., 24. There are now three vice-chancellors who, according to the dates of their appointment, take precedence next to the lords justices, they are appointed by the crown by letters patent, and hold their office during good behaviour. They have power to hear and determine all matters depending in the Court of Chancery either as a court of law or as a court of equity, or as incident to any ministerial office of the said court, or which are subjected to the jurisdiction of such court or of the lord chancellor by any special act of Parliament, as the lord chancellor shall from time to time direct. But all orders and decrees of the vice-chancellors must be signed by the lord chancellor, and the vice-chancellor has no power to alter or discharge any decree or order made by the lord chancellor, unless authorised by the lord chancellor, nor any power to alter or discharge any order or decree of the master of the rolls. The salary is 5000*l.* a year.

Each of these judges, or courts, has nearly an equal share of *original* power to dispense equity. An appeal (which, strictly speaking, is nothing more than a rehearing of the cause) may be had, as we have seen, from any decision of the master of the rolls or vice-chancellors to the lord chancellor, or to the Court of Appeal in Chancery, which has been of late years principally occupied with such appeals, original causes being generally confined to the courts of the master of the rolls and the vice-chancellors.

Besides the judges just mentioned, there were formerly other officers of the Court of Chancery by whom certain parts of its equitable jurisdiction were exercised. The principal of these officers were the masters in ordinary, and the accountant-general. The former office has been abolished; the latter remains one of the most important officers of this court. [Accountant-General.] The masters were ten in number, besides the master of the rolls, who was the chief of them. It was their duty to execute the orders of the court upon references made to them, and by reports in writing to show how they had executed such orders; but it would be impossible to specify every head of reference to the masters, because they were almost as numerous as the subjects of the court's jurisdiction. Their duties have now been transferred partly to the judge and partly to the chief clerks of the judge. The latter have now to take the accounts of executors, administrators, or trustees, or between any parties whatsoever; to inquire into, and decide upon, the claims of creditors, legatees, and next of kin; to sell estates, and to approve of the investment of trust-money in the purchase of estates, and, for this purpose (or for any other, as the case may be), to investigate titles, and settle conveyances, referring the same, when necessary, to one of the six conveyancers appointed to advise the court in such matters; to inquire and report on applications for the appointment of guardians for infants, and the sums to be allowed for their maintenance and education; to settle lists of contributions on the winding up of joint-stock companies; and generally to inquire into and inform the conscience of the equity judge upon such matters of fact as are referred to them.

Besides these officers, each court has its registrars, and the Court of Chancery generally a body of taxing masters, to tax the bills of costs of the suitors, and a numerous staff of record and writ clerks, who attend to its process, and file and preserve its proceedings.

The jurisdiction exercised in the Court of Chancery will be explained under another head [Equity]; in this place it will be sufficient to refer to another and distinct though but a small part of its business, which arises on what is called *the common law jurisdiction of the Court of Chancery*.

It is here that proceedings by and against the crown (other than matters of revenue, which are cognisable in the Exchequer) originate. [Monstrans de Droit; Petition of Right.] To this common law jurisdiction of the Court of Chancery also belongs the power of issuing certain *writs;* particularly the commissions of the peace, and the writs of *habeas corpus*, and of *certiorari* and *prohibition*. "In this ordinary or legal court," says Blackstone, "is kept the *officina justitiæ*, out of which all original writs that pass the great seal, all letters patent, and all commissions of charitable uses, sewers, idiotcy, lunacy, and the like do issue." The issuing of original writs however is now unfrequent; for these writs, which were formerly the foundation of all actions in the courts of law at Westminster, have, with few exceptions, been abolished by recent statutes.

The place where this common law jurisdiction is exercised is the *petty-bag office*, which is kept solely for this purpose; and the Court of Chancery, in respect of this jurisdiction, is said to be a court *of record*, which, as a court of equity, it is not.

In each of the counties palatine of Lancaster and Durham, and in Ireland, there is a Court of Chancery, which dispenses the same equity within the limits of its jurisdiction as the High Court of Chancery. In the Irish Court of Chancery the lord chancellor of Ireland presides. From the Lancaster court the appeal is to the lords justices; from the lord chancellor's decree, or that of the Court of Appeal in Chancery, the appeal is immediately to the House of Lords.

In imitation of the High Court of Chancery in England, various local courts of equity have sprung up in the British dominions and dependencies, which are generally called courts of chancery; but the equity administered in them appears not to be the settled system which exists in this country, the governors of the colonies being generally the judges.

Many of the states of North America have their courts of chancery; but the equitable jurisdiction of some of these is, it seems, more discretionary than that of our own courts of equity. In others of the states the courts of equity which formerly existed have been abolished; and in New York especially, the system of equity which was formerly separately administered as in England, has now been consolidated with the law, so as to constitute one system of jurisprudence, administered in one series of tribunals of original and appellate jurisdiction.

CHANCERY, INNS OF. [Inns of Court.]

CHANTRY (in the middle-age Latin, *Cantária*), a private religious foundation, of which there were many in England before the Reformation, established for keeping up a perpetual succession of prayers for the prosperity of the founder's family while living, and the repose of the souls of those members of it who were deceased. These foundations owed their origin to the opinion prevalent in the early Church, of the efficacy of prayer in respect of the dead as well as the living; and amongst the English, always a devout people, it prevailed in all ranks of society. The inscriptions upon the gravestones of persons of ordinary condition in the times before the Reformation almost always began with "Orate pro animâ," which was an appeal to those who resorted to the church, to remember to pray for the soul of the person who slept below. Princes and persons of great wealth, when they founded monasteries, included, amongst the duties of the monks, that they should receive in them their earthly remains, and for ever make mention of the founders in their daily services. When the taste for founding monasteries declined, about the close of the 12th century, the disposition to secure the same object by the foundation of chantries began to prevail, and it continued with unabated zeal to the very eve of the Reformation, when all such foundations were swept away as superstitious.

A chantry did not necessarily require that any edifice should be erected for it; they were usually founded in churches already existing: sometimes the churches of the monasteries, sometimes the great cathedral or conventual churches, but very frequently the common parish church, whether in a town or in a rural district. All that was wanted was an altar with a little area before it, and a few appendages; and places were easily found in churches of even small dimensions, in which such an altar could be raised without interfering inconveniently with the more public and general purposes for which the churches were erected. An attentive observation of the fabric of the parish churches of England will often detect where these chantries have been, in some small remains, perhaps, of the altar, which was removed at the Reformation, but more frequently in one of those ornamented niches called piscinas, which were always placed in proximity with the altars. Sometimes there are remains of painted glass which it is easy to see has once been the ornament of one of these private foundations; and more frequently one of those arched recesses in the wall which are called Founders' Tombs, and which in many instances, no doubt, were actually the tombs of persons to whose memory chantries had been instituted.

In churches which consisted of only nave and chancel with side aisles, the eastern extremities of the north and south aisles were often used for these foundations; in the larger churches, having transepts, these were generally devoted to a similar use. In the great conventual churches and the churches of monasteries, it would appear as if provision had been expressly made for these private chantries in the original construction of the edifice, each window looking eastward being often made to light a small apartment just sufficient to contain an altar and a little space for the officiating priest.

It was by no means unusual to have four, five, or six different chantries in a common parish church; while in the great churches, such as old St. Paul's in London, the Minster at York, and other ecclesiastical edifices of that class, there were at the time of the Reformation thirty, forty, or fifty such foundations. When the fabric of a church afforded of itself no more space for the introduction of chantries, it was usual for the founders to attach little chapels to the edifice. It is these chantry chapels, the use and occasion of which are now so generally forgotten, which occasion so much of the irregularity of design which is apparent in the parish churches of England. Erected also, as they generally were, in the style of architecture which prevailed at the time, and not in accordance with that of the original fabric, they are a principal cause of that want of congruity which is

perceived in the architecture of different parts of the parish churches, but they contribute much to their picturesqueness.

When chapels were erected for the especial purpose of the chantries, they were usually also the places of interment of the founder and his family, whence we sometimes find such chapels belonging, even to this day, to particular families, and adorned with monuments of many generations. One of the most beautiful chapels of this kind is in the little village of Sandal, a few miles from Doncaster, the foundation of Rokeby, archbishop of Dublin, who died in 1521. The church of Sandal, being small, afforded no scope for the design of this magnificent prelate. Having, therefore, determined that here should be the place of his interment and the perpetual celebrations in his memory, he erected a chapel on the north side of the choir, open however to the church on one side, being separated from it only by open wainscot. On entering it by the door one sees at once the whole economy of one of these chapels. Under the window looking eastward an altar has stood; the piscina on the right remains. On each side of the east window is a niche where once, no doubt, stood an effigy of a saint whom the archbishop held in peculiar honour. In the centre is a brass indicating the spot in which the body of the prelate lies; and in the north wall is a memorial of him, having his arms and effigy, with an inscription setting forth his name and rank, and the day of his decease, with divers pious ejaculations. The stone- and wood-work have been wrought with exquisite care, and the windows appear to have been all of painted glass.

Chantries were sometimes also established in edifices remote from any church, a chapel being erected for the express purpose.

In chantries of royal foundation, or in chantries founded by the more eminent prelates or barons, the service was conducted sometimes by more than one person. But usually there was but one officiating priest. The foundation deeds generally contain a distinct specification of his duties, which consisted for the most part in the repetition of certain masses; but sometimes the instruction of youth and the delivering of pious discourses to the people made part of the duty of the chantry-priests. They also contain an account of the land settled by the founder for the support of the priest. The names of the persons whom he was especially to name in his services are set forth, as well as the mode of his appointment and the circumstances in which he might be removed. Generally the king was named together with the founder and members of his family. This, it was supposed, gave an additional chance of the foundation being perpetuated. The licence of the crown was generally obtained for the foundation.

In many towns and country places there are ancient houses known by the name of chantry houses, or sometimes chantries, or colleges. These have been places of residence of the chantry priests, and were called colleges, where they lived (a considerable number of them being in one church) a kind of collegiate life, it being held that the clergy should mix but little with the laity. These, as well as all other property given for the support of the chantry priests, were seized by the crown and sold to private persons, when, by the Statute 1 Edward VI. c. 14, all foundations of this kind were absolutely suppressed and their revenues given to the crown. An account had been taken a few years before of all the property which was settled to these uses, by the commissioners under the Act 26 Hen. VIII. c. 2, whose returns form that most important ecclesiastical document the 'Valor Ecclesiasticus' of King Henry VIII. The 'Valor' has been published by the commissioners on the Public Records, in five volumes folio.

CHAPEL (*capella*), a word common to many of the languages of modern Europe, and used to designate an edifice of the lower rank appropriated to religious worship. Its origin and etymology are very obscure.

In England it has been used to designate minor religious edifices founded under very different circumstances and for different objects.

1. We have a great number of rural ecclesiastical edifices, especially in the north of England, where the parishes are large, which are not, properly speaking, churches, *ecclesiæ*, though in common parlance they are sometimes so called, but are chapels, and not unfrequently called parochial chapels. Most of these are of ancient foundation, but still not so ancient as the time when the parochial distribution of England was regarded as complete, and the right to tithe and offerings determined to belong to the rector of some particular church. In the large parishes it frequently occurred that a family of rank which resided at an inconvenient distance from the parish church, would desire to have an edifice near to them, to which they and their tenants could resort for the benefit of Christian ordinances. On reasonable cause being shown, the bishop would often yield to applications of this kind; but in such cases he would not suffer the rights of the parish church to be infringed; no tithe was to be subtracted from it and given to the newly erected foundation, nor was that foundation to be accounted in rank equal to the older church, or its incumbent otherwise than an inferior and subordinate minister to the incumbent of the parish church. But the bishop generally, perhaps always, stipulated that there should be an endowment by the founder of such an edifice. Not unfrequently in edifices of this class there was the double purpose of obtaining a place of easier resort for religious worship and ordinances, and a place in which perpetual prayers might be offered for the family of the founder. [CHANTRY.] Others of these rural chapels were founded by the devotion of the parishioners. The population of a village which lay remote from the church of the parish within whose limits it was included would increase, and thus the public inconvenience of having to resort to the parish church on occasion of christenings, churchings, marriages, and funerals, besides the services on the festivals, become great; they would therefore apply to the bishop in petitions, many of which are to be found in the registers of the sees, setting forth the distance at which they lived, the impediments, constant or occasional, in the way of their ready resort to the parish church, as want of good roads, snow, the rising of waters, and the like, on which the ordinary would grant them the leave which they desired, reserving, however,—as seems almost always to have been the case,—whatever rights and emoluments had beforetime belonged to the parish church. In the parish of Halifax there are twelve of these chapels, all founded before the Reformation. In the parish of Manchester, and in most of the parishes of Lancashire, such subsidiary foundations exist in great number. Those foundations of this class which could be brought within the description of superstitious foundations, were dissolved by the Act 1 Edward VI. c. 14, for the suppression of chantries; but while the endowment was seized, it not unfrequently happened that the building itself, out of the piety of the person into whose hands it passed in the sale of the chantry lands, or the devotion of the persons living near it and long accustomed to resort to it, continued to be used for the reformed worship, and remains to this day a Christian church, the incumbent being supported by the casual endowments of the period since the Reformation, and especially by what is called Queen Anne's Bounty, in which most of the incumbents of chapels of this class have more or less participated.

2. The term chapel is used to designate those more private places for the celebration of religious ordinances in the castles or dwelling-houses of distinguished persons. We find in the fabrics of some of the oldest specimens of the castles of England some small apartment which has evidently been used for the purposes of devotion, and this sometimes in the keep, the place of last resort in the time of a siege. A remarkable instance of this is at Conisbrough, in Yorkshire. But in castles of the time of Edward I. and subsequently, chapels of this kind were erected adjoining the apartments appropriated to the residence of the family. Most of the baronial residences, it is probable, had chapels of this kind, and how splendid they sometimes were we may see in St. George's Chapel at Windsor.

3. The chapels of colleges, as in the two universities; of hospitals, or other similar foundations.

4. Chapels for private services, chiefly services for the dead, in the greater churches, as the chapel of St. Erasmus, and others, in the church of Westminster. Additions made to the parish churches for the purpose of chantries are sometimes called chantry chapels.

5. Places of worship of modern foundation, especially those in towns, are called chapels of ease, being erected for the convenience of the inhabitants when they have become too numerous for the narrow limits of their parish church. Many of these have had districts assigned to them with cure of souls, and the right of celebrating baptisms, marriages, &c., under the provisions of special Acts of Parliament, in which the rights and duties of the incumbent and the founders are defined.

6. The word chapel is pretty generally used to denote the places of worship erected by Dissenters, though the Quakers and the more rigid of some religious denominations, out of dislike to the nomenclature of an ecclesiastical system which they do not approve, prefer to call such edifices by the name of meeting-houses.

CHAPLAIN, *capellanus*, a word formed immediately on the word chapel, *capella*, according to one of the commonest analogies of our language.

A chaplain is properly a clergyman officiating in a chapel in contradistinction to one who is the incumbent of a parish church; hence the clergymen appointed to the army and navy are called chaplains, as well as those performing duty in union workhouses. But its more frequent use is now as designating clergymen who are either residing in families of distinction and actually performing religious services in the family; or who are supposed to be so, though not actually so engaged. This fiction proceeds on the assumption that every bishop and nobleman, with some of the great officers of state, have each their private chapel, to which they nominate a priest, or more than one. Certain privileges respecting the holding of benefices belong to these chaplains, by reservation out of the Act against Pluralities 21 Hen. VIII., c. 13. The power of appointment in the sovereign is unlimited; the number of chaplains which noblemen and other persons may nominate is fixed: an archbishop may have eight; a duke or a bishop, six; a marquis or earl, five; a viscount, four; a baron, knight of the garter, or the lord chancellor, three; the treasurer of the king's house, the comptroller of the king's house, the clerk of the closet, the king's secretary, the dean of the chapel, the almoner, and the master of the rolls, may each nominate two; the chief justice of the Queen's Bench and the warden of the Cinque Ports, each one; a duchess, marchioness, countess and baroness, being widows, are allowed to nominate each two.

CHAPTER. The canons in the cathedral or conventual churches, when assembled, form what is called the chapter, *capitulum*, anciently the council of the bishop. [CANON.] Other religious communities, when assembled for business, sat in *chapter*. Attached to many cathe-

dral and conventual churches are buildings for the meeting of the chapter, called chapter-houses. The buildings of this kind connected with Westminster Abbey and York Minster, are octagonal and of singular beauty. [CHURCH.]

The members of the College of Arms, that is, the heralds and pursuivants, are said to hold a *chapter* when they sit together to confer on the business of their office.

CHAPTER-HOUSE. [CHURCH.]

CHARACTERISTIC (of a logarithm). The whole number, positive or negative, which precedes the decimal point of a logarithm. The reason of this number having a separate name is, that in Brigg's system it is so easily found as not to form a part of the tables. [LOGARITHM.] In truth, it ought to be called the *characteristic* of the primitive number of the logarithm; and the following theorem should be announced,—The characteristic of a number is the integer portion of its logarithm.

CHARADE, a species of riddle, in which a word consisting of several syllables is indicated, first by an enigmatical description of each syllable, taken separately, and then by a similar description of the whole. It does not seem to be necessary that the word should consist only of two syllables, according to the definition given in most of our English dictionaries and cyclopædias. To have anything of wit or point, a charade should be so contrived, that the ideas employed to denote or suggest the several syllables, and the entire word, shall be all in some way connected together, or arise naturally the one out of the other. This however is often neglected. The following, which we find in the late editions of the dictionary of the French Academy, is not a bad example of a true charade: "My first makes use of my second to eat my whole;" the translation being the word *chiendent* (dog's grass). The word charade is said to be derived from the name of the inventor of this particular species of enigma. Some of the best specimens of this kind of exercise of ingenuity were written in verse by the late Winthrop Mackworth Praed, and appeared originally in Knight's 'Quarterly Magazine,' where they were called enigmas. The term appears to be originally French, and not to have come into use till towards the end of the last century.

CHARCOAL is the impure carbon obtained by the decomposition of vegetable matter by heat without free access of air; during this operation the more volatile elements of the woody fibre are expelled as new compounds, while the carbon the fixed ingredient, remains, mixed however with some saline matter, presently to be noticed, which renders it impure.

What occurs during the preparation of charcoal will be readily understood by referring to the analysis of woody fibre by MM. Gay Lussac and Thénard, who found, whatever be the kind of wood employed, that after drying at 212° Fahr. it yielded upon an average—

Carbon	52
Hydrogen	5·3
Oxygen	42·7
	100·0

Now as the oxygen and hydrogen are almost exactly in the proportions required to form water, it would appear that if these only could be expelled by heat, the products of the decomposition would be carbon and water. We shall, however, presently mention, that owing to the combination of a part of the carbon with these elements, and also of the oxygen of the air, the compounds which arise from the decomposition of wood are much more complicated, and are of very great importance.

The making of charcoal for domestic uses, and probably also for such manufacturing or metallurgic processes as the ancients were acquainted with, is of high antiquity. Pliny (lib. 16, c. 6) mentions that the wood was formed into a pile, the top of which was covered with clay; evidently to prevent the access of too much air, by which, as experience had no doubt taught, it was found that the wood was converted entirely into ashes.

Charcoal is now prepared by two different methods: one, resembling in principle that just mentioned, consists in piling the wood in a heap, which is covered with turfs and sand to allow of the entrance of such a portion only of atmospheric air as is sufficient to carry on the imperfect combustion required. The heap is fired at several holes left near the bottom, and a draught of air is obtained by at first leaving an orifice at the top of the heap; this is afterwards covered, and when it is found that the flame has pervaded the heap entirely, the bottom holes are also closed. When the mass has cooled, the charcoal remains.

Within a comparatively few years another method of obtaining charcoal has been adopted, by which the article obtained is said to be better adapted for the purpose of making gunpowder. This is done by putting the wood into iron cylinders, which are set in brickwork and surrounded by fire; the wood in the cylinders has no communication with the external air, and they have only a small opening to allow of the escape of the gaseous products arising from the decomposition of the wood, and the new compounds derived from the combination of its oxygen and hydrogen with a portion of the carbon.

These products, or at least those which are condensible, are chiefly water, tar, impure acetic acid, usually called pyroligneous acid [ACETIC ACID], creosote [CREOSOTE], pyroxylic spirit [PYROXYLIC SPIRIT], and empyreumatic oil. One hundred parts of oak wood dried in the air yielded 43 of pyroligneous acid, about 4·5 parts of carbonate of potash, 9·06 parts of empyreumatic oil, and 26·2 of carbon; different woods yielded somewhat varying proportions of these substances, but the oak gave the largest quantity of charcoal.

Although the charcoal thus procured is preferable for making gunpowder, yet it is stated that it is not so well liked for many other purposes; it is also said to be much lighter than that made in the usual way, and this appears to occasion some variation in the degree of heat required for its consumption in a given time, and thus influences many operations. The densest charcoal gives the most heat while burning.

The general properties of charcoal are, that it is black, sonorous, and brittle, and retains the form of the wood from which it is obtained; it is insoluble in water; infusible and fixed in the most intense heat ever produced. It is a very bad conductor of heat, but conducts electricity. Its property of condensing various gaseous bodies has been already noticed, as well as the compounds which it forms with some other elements. It has considerable antiseptic powers. [CARBON.]

It has been mentioned that certain impurities exist in the charcoal of wood; thus when 100 parts of old oak wood are entirely burnt, there remain about 5 parts of ashes, and different woods furnish very different proportions of them; these ashes are principally carbonate of potash [POTASSIUM], unquestionably derived from the decomposition of some salt containing a vegetable acid, as the tartaric or malic. It has been thought that the spontaneous combustion which charcoal has been known occasionally to undergo, has been occasioned by a portion of potassium having been reduced to its metallic state, and the subsequent action of moisture upon it. For an account of the different quantities of charcoal and ashes obtained from different kinds of wood, see Dumas, 'Traité de Chimie,' tome i. p. 558; and see also in 'Phil. Mag.,' vol. iii., a paper by M. Mushet, on the same subject.

CHARCOAL, ANIMAL. [BONE BLACK.]

CHARGE, in the practice of artillery, denotes the quantity of powder placed in a gun, howitzer, or mortar, for the purpose of expelling the shot or shell by its explosion.

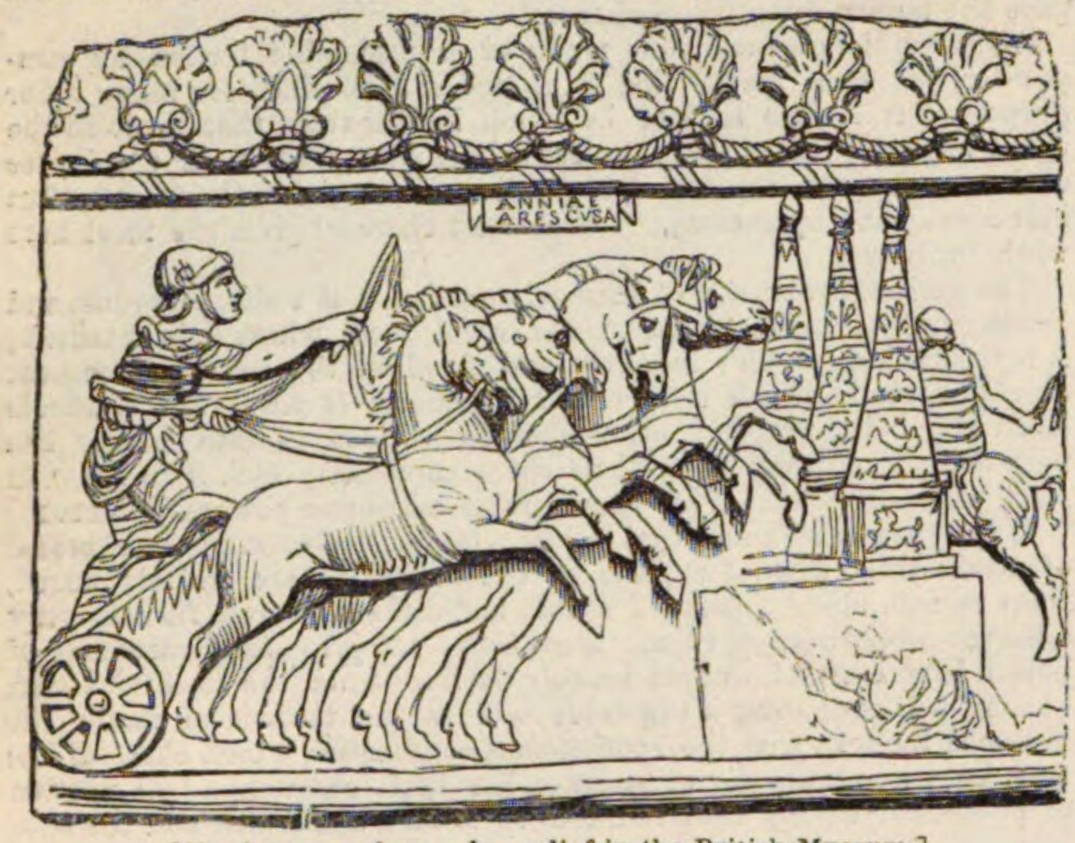
The service-charge varies from one-sixth to one-third of the weight of the projectile: the lower charges being used in the field, or in naval actions; and the higher in breaching the walls of fortresses. It is evident that extensive ranges and great velocities of shot are not required when artillery is directed against an enemy's columns or lines; and it is found by experiment that a ball which just pierces the timbers of a ship will fracture them more than if it passed rapidly through them. On the other hand, the greatest momentum is necessary on commencing the formation of a breach in a rampart faced with brick or stonework, as the depth to which the shot will penetrate is thereby increased; and therefore the highest charges are then required.

According to Dr. Hutton (Tract 34), different charges of powder, when the weight of the ball remains the same, produce velocities which are as the square roots of the weight of powder; and when the weight of powder is the same while that of the ball varies, the velocities are inversely proportional to the square roots of the weight of the balls. The Doctor states, also, that the greatest velocities are produced in guns, the lengths of whose bores are equal to fifteen, twenty, and thirty calibres, or diameters, by charges occupying $\frac{3}{10}$, $\frac{3}{12}$, and $\frac{3}{16}$ of the lengths of the bores respectively; and he adds, that by increasing the quantity of the charge, the velocities increase till they amount to a certain value, after which they decrease till the bore is quite filled with powder. The charge producing the maximum velocity is greater as the gun is longer; but it does not increase in so high a ratio as the length of the gun.

CHARGE' D'AFFAIRES, one who transacts diplomatic business at a foreign court during the absence of his superior, the ambassador. The agents that bear this name also form a separate class, being the chosen envoys or residents at the states to which other states do not appoint diplomatists of the higher grades. In this capacity the Chargés d'Affaires act for themselves, represent their country, and are independent of any ambassador. In the ordinary routine and course of promotion, the secretary of legation, or secretary of embassy, becomes a Chargé d'Affaires. For their privileges and duties see AMBASSADOR. In this year (1859) the British Chargés d'Affaires on the diplomatic list are all those to the various republics of South America, and to the empire of Morocco.

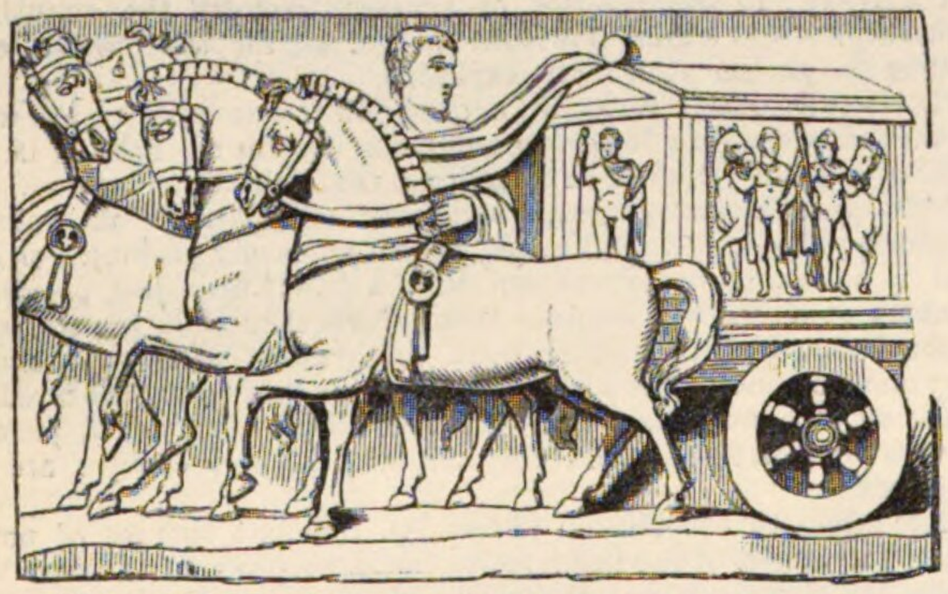
CHARIOT, a light sort of coach; also, a car (currus), in which men of arms were placed in fight. The name is derived from the French word *charrette*. Cars or chariots are of very early use. The invention of them was attributed by the Greeks to Minerva (Hom. 'Hymn. in Ven.' v. 12), on which account she was venerated at Athens and various other places in Greece under the name of Hippia: and the honour of the invention was shared by Erichthonius, who, according to Virgil, was supposed to have first harnessed horses to a car, and to have introduced chariot-races at the Panathenæa which were established by him. The ancient chariot had but two wheels, and was open overhead. It appears to have been usually drawn by two horses, but in races three and even four horses were not uncommonly yoked to it. Of the Roman *biga*, or two-horsed chariot, a representation is given under BIGA. The three-horse chariot was called a

triga, one of four-horses a *quadriga*. The war chariot carried two persons, one of whom was the driver, who stood in front. The chariots used by the Romans in their public games only carried the driver. The race chariots were often very richly adorned. The



[Chariot Race, from a bas-relief in the British Museum.]

most splendid of the Roman chariots were, however, those employed in triumphs. The funeral chariot was also adorned in a very costly manner.



[Funeral Chariot, from a bas-relief in the British Museum.]

The most ancient war-chariots we know of are those of Pharaoh, which were overwhelmed in the Red Sea. (Exod. xiv. 7.) The Canaanites whom Joshua engaged at the waters of Merom had a multitude of chariots. (Josh. xi. 4.) And the Philistines, in their war against Saul, are stated (1 Sam. xiii. 5) to have had thirty thousand chariots.

Chariots armed with scythes were in use for many ages in all the Eastern countries; and were regarded as a principal arm of war. Such are mentioned in the Second Book of Maccabees (xiii. 2), which the king of Syria led against Judæa. They were used by the Persians, as we see from Xenophon ('Anab.' i. 8); and they constituted a remarkable feature in the armies of the ancient Britons. Cæsar ('De Bell. Gall.' v. 19) says, that after Cassivellaunus had dismissed all his other forces, he had still four thousand of these war-chariots about his person. See Cæsar's account of the method used in fighting with them (iv. 33).

The Essedum and the Rheda were among the Roman war-chariots of the larger size. Greek and Roman chariots frequently occur on the reverses of medals. The modern chariot is a mere coach-maker's modification of the ordinary private coach or carriage.

CHARITABLE USES. [Uses, Charitable.]

CHARITIES. [Uses, Trusts.] By the Charitable Trusts Act, 1853, a body of commissioners has been created for England and Wales, with power to inquire into all charities, their nature, objects, and administration, and the condition of the property belonging to them; to require the production of accounts and documents from the trustees of charities, and to cause inspectors to visit and report on their management. No proceeding with reference to any charity can be taken by any *relator* without the sanction of this board, which is called "The Charity Commissioners for England and Wales;" the attorney-general alone may proceed by *ex officio* information. The board may direct in what court proceedings for the administration of any charity are to be taken; but where the income is under 30*l*., the county court of the district, or the court of bankruptcy of the district, in which the charity is situated, has jurisdiction. In other cases the court of chancery must be resorted to. The statute does not extend to Scotland or Ireland, to the Universities, or the city of London. A report of the proceedings of the board must be annually laid before Parliament

CHARLES'S WAIN, a name for the Great Bear [Ursa Major]. This constellation was also formerly called "the brood hen," in England. (Robert Recorde, 'Castle of Knowledge.') This constellation was sometimes called a waggon, both by the Arabs and Romans; but who Charles may have been we have no means of knowing, not having an English Hyginus of sufficient antiquity to be authority as to this personage.

CHARON, son of Erebos, was the fabulous boatman who conveyed the shades of the departed across the rivers which girt the infernal regions. (Eurip. 'Alcest.' 253, 441; Aristoph. 'Ran.' 202; Virgil, 'Æneis,' v. 298.) His fare was an obol (the sixth part of a drachme), which was laid in the mouth of a person about to be buried, in order that he might have wherewith to pay the freight. (*ναῦλον, δανάκη.* Aristoph.; J. Pollux, ix. 82; and Juvenal, iii. 267.) Charon does not appear in Homer; his origin is referred to Ægypt (Diodor. i. 90), where he had a representative in Amenthes, the emblem of a future state: his name is thought to point to the joy produced by a freedom from sublunary troubles. (See Creuzer, 'Symbolik.' i. p. 341.)

CHART, or SEA-CHART, a hydrographical map, or a projection of some part of the sea, *in plano*, for the use of navigation. Fournier, in his 'Hydrographie,' (fol. par. 1667, p. 505,) ascribes the invention of charts to Henry, son of John, king of Portugal; certain it is that marine charts appear first to have issued from the Portuguese. Bagford says, the first step that was made toward a knowledge of our own coasts was by an almanac, with a chart of the coasting part of England, printed on vellum or parchment, by Wynken de Worde, 1520, and bound in a small portable volume. This was the first he had seen of the kind. (See Bagford's 'Letter to Hearne,' prefixed to Leland's 'Itinerary,' vol. i. p. lxxx., and 'Spicileg. ad Gul. Neubrig., p. 749.) John Rotz, a native of Dieppe, and servant to King Henry VIII., made for the king's use a Book of Hydrography, so called, being an account of the compass, elevation of the pole, latitude, sea coasts, &c., 1542, finely painted on eighteen very large skins of parchment, still preserved among the royal manuscripts in the British Museum, marked 20 E., ix. Of this description also is a very curious chart, preserved in the same collection, formerly belonging to Lord Oxford, and probably of as early, if not an earlier date than Rotz's charts. New Holland is laid down upon it as an island, under the name of Java le Grand. The writer of the present article, many years ago, consulted the late Captain Flinders for his opinion whether this portion of the chart could have been laid down from actual observation. The answer was, "Most certainly; for lines of red dots are made to border the coast exactly to the extent to which it is coral-bound, and no farther; I was wrecked upon one of those reefs, and have reason to remember them." The names of places are occasionally given upon the different shores in this chart, in French; and the very spot upon it which Captain Cook afterwards named Botany Bay is designated as *Côte des Herbages*.

The generality of the early Portuguese charts seem to have been made toward the close of the 15th century. Through the encouragement given by the Board of Admiralty, excellent surveys have of late years been made of our own and many foreign coasts. But the increased speed of steamers bears obviously upon the question of *extreme accuracy* in charts, with a force which the hydrographic department of the Admiralty seems fully to appreciate. It is worthy of consideration whether the establishing of a systematic scheme of *colouring the soundings* on what may be called "pilot charts," *so as to indicate equal depths of water by the same shade of colour*, would not more rapidly convey useful information thereupon; such information as would take firmer hold upon the memory.

For instance, and as a system adapted to navigation, all depths under 10 feet at low-water spring tides might be left the colour of the paper of the chart. The various shallows occurring in this space would at a glance be known at once by the ordinary method of "dotting;" indeed, if advisable, a dotted line indicating "one fathom" might, as at present, be continued for the convenience of vessels of very light draught of water.

Between	10	feet depth	and	20	feet	might be coloured	pale, but distinct, yellow. (chrome yellow.)
,,	20	,,	,,	30	,,	,,	pale carmine.
,,	30	,,	,,	40	,,	,,	deeper carmine.
,,	40	,,	,,	50	,,	,,	pale sepia.
,,	50	,,	,,	60	,,	,,	deeper sepia.
,,	60	,,	,,	70	,,	,,	pale neutral tint.
,,	70	,,	,,	80	,,	,,	deeper neutral tint.
,,	80	,,	,,	90	,,	,,	pale purple.
,,	90	,,	,,	100	,,	,,	deeper purple.

Further colouring on pilot charts would be unnecessary; but as the subject of the introduction of the submerged telegraph cable is in its mere infancy, and future discoverers may very probably produce cheaper cable and apparatus, leading to the more extended adoption of telegraphic communications across narrow estuaries or channels, it might soon be found advisable to adopt a mode of colouring to *greater depths* of water. In such case, all would soon be accomplished with-

out chance of confusion by adding a cypher to the above figures, retaining the same gradations of colour and carrying us on to 1000 feet.

It will be seen from the above, that coasting vessels will have to regard principally the pale yellow and uncoloured soundings, while larger ships would only have in most cases to regard the pale carmine, except when anchorage became the question, when the ordinary figures indicating soundings would be available as at present. Nothing that could simplify navigation should in these days be rejected.

Nor is it unimportant that fishermen upon our coasts, seeing (at a glance on such charts) the holes and deeps and conformations at the bottom of the sea, and knowing traditionally the habits of their prey, might thus be directed to more successful captures.

By attention to this colouring of charts some curious geological deductions would doubtless result. As an example: The writer's first impression on seeing a chart of the entrance to the Thames thus coloured by him for his amusement, was, that at a distant period the "River Thames" lay entirely northward of a line which may be drawn from the Long Sand Head to the "Shivering Sand," thence to the "East Cant," thence to the "Cant," and thence to "Garrison Point," Sheerness. That the space between this said line and another drawn from near the Long Sand Head on the eastward of the present Long Sand, and trending southward, passing to the eastward of the Margate Sand, and joining the mainland eastward of the Reculvers, *formerly inclosed dry land, constituting an extensive promontory of Kent.* It would thus seem probable that the "Prince's" and "Queen's" channels are of comparatively recent formation, originating in the denudation of the soft strata of the tertiary from what is now the Margate Sand, and the large area of the "Flats" off Whitstable; thus forming a new eastern entrance to the Thames by the "West Girdler," and in process of time washing the coast-line into its present form. *This work is even at the present day progressing;* and few, having a knowledge of this fact, and being aware of the nature of the tertiary formation, would on inspecting a chart *carefully coloured as to soundings*, doubt the *general* accuracy of the above.

As a further instance, we may even take the case of the Goodwin Sands, on the east coast of Kent. On seeing a coloured chart hereof, geological intimations and inferences are very striking. What do we find? An easy curve in the soundings, originating about two miles off the South Foreland, trending first towards the north-east, then northerly, and afterwards with an easy bend towards the north-west, marks the general line of the outer edge of the Goodwin, and lying, at its greatest distance, about 7 miles from (say) Deal, inclosing a space gradually shallowing towards the North Foreland, and embracing within its limits such inequalities of surface—known as the "Brake" sand, and sundry "knolls"—as one would suppose the action of the sea upon strata of such varied compactness and density as the "tertiary" would cause. On the outer edge of the Goodwin range, especially in the part exposed to the full action of the flood-tide from the English Channel, as accelerated by the narrowness of the Straits of Dover, we find as much as 30 or 40 fathoms of water. The return action of the ebb-tide seems, in its influence upon the North Goodwin Head, to have met with resistance from the chalk foundation on which the Goodwin Sands are known to rest. It is extremely probable, therefore, that chalk would be found at the "Goodwin knoll" a *very few* feet from the surface. Now, who will say that the "curve," as intimated in the coloured chart and alluded to as passing the outer Goodwin and returning easily towards the North Foreland, was not once the general coast-line of East Kent? Tradition tells us of the territories of Earl Goodwin in the time of Harold II., as it will some day point to a shoal on which "stood" the present Sandown Castle. History even points vaguely to the destruction and submersion, or "*overwhelming*," of the lands of Earl Goodwin. [KENT, in GEOG. DIV.] The same destruction is at the present day assailing Sandown Castle; it was only built in the reign of Henry VIII., but has already yielded its moat and outworks to its powerful assailant. One might, on seeing a coloured chart of the district, even go further, and declare that the flood-tide from the British Channel, gathering force as it sweeps the French coast past Cape Grisnez, strikes in a direct line towards the inside of the Goodwin or through the present Downs in such a manner as to account for the complete denudation of the strata along the east coast of Kent; and if any further proof of this abrasion be wanting, the *débris* has evidently been deposited along the coast opposite the North Foreland, forming the well-known *plateau* around it of from 6 to 7 miles diameter, and on which at most is found about 50 feet of water. The subject is interesting as important, especially as it requires some such considerations as the above to account for the vast results of a once moving water-power which once formed the chalk "cliffs" of Albion in their now *scarcely perceptibly* changing aspect. The comparative shallowness of the sea off the North Foreland is otherwise an obstacle to other attempts at elucidation; for it seems reasonable to suppose that the former action of *deep* water, and the then unchecked rush of flood-tide from Cape Grisnez, could alone have produced such stupendous results.

If anything can further justify a recommendation to colour charts of the coast, it may be the following, as indicating its tendency towards a creation of new ideas on certain subjects: Sandown Castle (above referred to), has been within the memory of living men, gradually and visibly suffering from the encroachment of the sea; while the celebrated Richborough Castle, only about five miles from it, and which in the time of the Romans (say 1800 years ago), was washed by the sea, now stands two full miles inland.

Antiquaries have sought all means whereby to reconcile this anomaly. But may we not again revert to the circumstance of the south-east coast of Kent, having been at one time so great an obstacle to the course of the channel flood-tide, as to have been gradually "scooped away" by the waters, until probably the sea reached the chalk barrier of the Isle of Thanet, which now ends at Pegwell Bay. On its approaching this limit, there being perhaps in those days much less room for the passage of the flood-tide inside the present Goodwin, the force of the tide into this "bight" or excavation, or narrow channel, would have considerably *raised the level of high water* above the adjacent shore, and have overflowed the marsh-land even to Richborough, forming at the same epoch the stream which insulated Thanet. History, in vague and dark traditions, acquaints us, however, that some 800 years after, a mighty storm or irruption of the sea overwhelmed the lands of Earl Goodwin (as already noticed). Now it is curious to consider the probability of this irruption having been nothing less than the bursting of some barrier of sand or strata, which by admitting the flood-tide in its less obstructed flow, drained the land at Richborough Castle, and reduced the "Wantsume," which insulated Thanet (and which from having in very early times been three or four miles wide, had in the year 700 gradually decreased to about half a mile), to the mere ditch of the present day.

We have an instance of this raising of the tide level, in the daily action of the sea in the Solent, and the causes which give to Southampton *twice highwater* in the same tide.

Such considerations may at first appear to be out of place under our word "chart," but knowledge springs from unexpected sources. An apple, a frog's leg, thoughts on a "pebble," each in its way has proved a lamp to the learned. A mere taper may enlighten Truth's magazine, and by its means we may pluck the rich and varied fruits of investigation, even from the dust of the air,—from a ray of light,—*why not from a tinge of colour in a wash of "carmine," or a streak of "sepia," or a stroke of "neutral tint?"*

The particular species of charts most used at sea will be explained under the head MERCATOR'S PROJECTION. See also MAP, and STEREOGRAPHIC, ORTHOGRAPHIC, GNOMONIC, and CONICAL PROJECTIONS, under which last head will be given Flamsteed's and the modern French projections.

CHARTE, from *charta*, "paper," though in its generic sense embracing every kind of legal instrument, has been restricted by modern usage, and signifies any ancient title-deed; but the name was given to the letters of franchise granted by the kings of France during the middle ages to several towns and communities, by which they were put in possession of certain municipal rights or privileges, such as the free election of their local magistrates, &c., a custom, according to Hallam ('Europe during the Middle Ages,' vol. i.), dating from the time of Louis VI., and becoming of almost universal application in France by the end of the 13th century. At present the word charte is used in France to signify the solemn acknowledgment made by Louis XVIII. on his restoration in 1814 of the rights of the nation, which was the fundamental law of the French constitutional monarchy, in principle somewhat resembling that of the English constitution as founded on Magna Charta and the Bill of Rights. By it the legislative power was vested in two chambers, peers and deputies, subject to the king's sanction. The former being composed of peers nominated by the crown, and holding either life or hereditary peerages as the crown might please; the latter comprising deputies whose age was to be at least 40, paying 1000 francs to the direct taxes, and nominated by electors of at least 30 years of age paying 300 francs to the direct taxes. All laws were to be promulgated by the king, the executive power being vested solely in him, who was to appoint to all the offices of the administration, both civil and military, and to have the command of all the military and naval forces. He also was to appoint the judicial officers, who, however, when once appointed were irremovable by him. The king was to make all treaties of peace, alliance, or commerce. His person was to be inviolable; but the ministers were to be responsible. One article of the Charte, having given occasion to a false interpretation, of which the ministers of Charles X. availed themselves to issue the famous ordonnances which gave rise to the revolution of July, 1830, was altered on the accession of Louis Philippe, and it was clearly explained that "the king issues the necessary ordonnances and regulations for the execution of the laws, without having the power in any case to suspend the course of the law or to delay its execution." The Charte, with this and one or two more modifications of minor importance, was sworn to by Louis Philippe on the 9th of August, 1830. Subsequently, a change was made by the legislature in the constitution of the Chamber of Peers, the peers being for life, and the peerage not being hereditary in their families.

The Charte consists of sixty-nine articles, and is inserted in the Almanac Royal et National; the principles of it are given in Alison's 'History of Europe, from the Fall of Napoleon,' vol. iv.

The system of law introduced by this charter remained in full force until the revolution of 1848, by which the government of Louis Philippe was overthrown and the republic instituted. On the acts of

that government, short lived and unacceptable to the French people as events seemed to prove, it is unnecessary to dwell; nor need we do more than advert to the rapid and startling changes by which the administration of affairs was surrendered to one individual, and the form of government altered from a republic one and indivisible, to an empire absolute and uncontrollable. But between the acts of that drama, the downfall of the republic and the elevation of the empire, a new constitution was promulgated on the 14th of January, 1852, preceded by a proclamation addressed to the French people, in which the principles of the Revolution of 1789 were emphatically appealed to, and the Constitution of the year viii. of the Republic, with the Napoleonic modifications, relied upon as the foundation of the new system. The constitution thus proclaimed contains eight chapters, in the first of which the announcement of the constitution is solemnly made; in the second, the forms of the government are stated; in the third, the position and duties of the president are fixed; in the fourth, fifth, and sixth, the senate, the legislative body, and the council of state are defined; in the seventh, the high court of justice is described; and the eighth contains certain general and transitory provisions. To this constitution a decree was added, consisting of thirty-four articles, constituting and regulating the council of state; and on the 22nd of January, sundry other decrees appeared, by one of which an office called that of minister of state was established, whose functions were carefully defined. A decree of the 22nd of March was promulgated, with the view of describing the relations of the senate and legislative chamber to the council of state, and securing the harmonious action of these three bodies. Finally, on the 23rd of December, 1852, another decree, or rather senatus consultum, appeared, by which Napoleon, by the grace of God and the national will, emperor of the French, explained and modified the Constitution of January 14th, 1852. For the particulars of this document, as well as those above-mentioned, the reader is referred to the 'Annual Register' for the year 1852.

CHARTER. This word is from the Latin *charta*, a word of uncertain origin: the Greek form of the word is *chartes* (χάρτης). Charta appears to have signified writing-material made of papyrus. The term was afterwards applied, not only to the materials for writing, but to the writing itself, as to a letter or the leaf of a book. In English law it was used to denote any public instrument, deed, or writing, being written evidence of things done between man and man, and standing as a perpetual record. (Bracton, lib. 2, c. 26.) Among the Saxons such instruments were known as *gewrite*, or writings.

Charters are divided into: 1. Charters of the crown; 2. Charters of private persons.

1. Royal charters were used at a very early period, for grants of privileges, exemptions, lands, honours, pardon, and other benefits that the crown had to confer; and thus the term became restricted to such instruments as conferred some right or franchise. These instruments did not differ in form from letters patent, being usually addressed by the king to all his subjects, and exposed to open view, with the great seal pendent at the bottom; but such as contained grants of particular kinds were distinguished by the name of charters. Thus, as giving was the object of a charter, the term became very popular, and was used in a more extended sense, to denote laws of a popular character.

Whatever may have been the prerogatives and legislative authority of the kings of England, it is certain that from the earliest times there were many rights and liberties which by the law of the land belonged to the people. As these were often restrained and violated, nothing was more acceptable to the nation than a formal recognition of them by the crown; and the popular name of charter was applied to those written laws by which the kings from time to time confirmed or enlarged the liberties of the people. Such laws were regarded, not only as concessions from the king, but as contracts between man and man —between the king and his subjects; while, at the same time, they were promulgated as the legislative acts of the sovereign authority in the state.

The charter of William the Conqueror, for observing the laws throughout England, was in the nature of a public law. It settled the religion of the state, and provided for its peace and government, for the administration of justice, the punishment of criminals, and the regulation of markets; it confirmed the titles to lands, and the exemption of the tenants in chief of the crown from all unjust exaction and from tallage. The words are those of a lawgiver appointing and commanding; "*statuimus*," "*volumus et firmiter precipimus*," "*interdicimus*," "*decretum est*," are the expressions by which matters are ordered or prohibited. ('Fœdera Rec. Comm. Ed.,' vol. i. p. 1.)

The charters of liberties granted by Henry I., Stephen, Henry II., John, Henry III., and Edward I. are all, more or less, in the nature of public laws, either making new provisions, or confirming, enlarging, and explaining existing laws, and relate to the freedom and good government of the people, and all the most important interests of the country. Some of them are still regarded as authoritative declarations of the rights and privileges which the people of England have enjoyed for centuries. So valid and binding were the royal charters considered, that in the 37 Hen. III. (1253), in the presence of the king, several of the first nobles, "and other estates of the realm of England," the archbishop and bishops, excommunicated and accursed all who should violate or change "the Church's liberties or the ancient approved customs of the realm, and chiefly the liberties contained in the charters of the common liberties and of the forest, granted by our lord the king." In those times no sanction more solemn could have been given to the authority of any law. It was intended chiefly as a check upon the king himself, whose power had been restrained by the popular concessions made in the charters of liberties; but it was also directed against all his subjects who should violate the liberties of the people. [Magna Charta.]

These charter-laws, though often expressed to have been made by the advice of the king's council, implied an absolute legislative power vested in the crown; and as royal prerogative became restrained and the public liberties enlarged, legislation by charter was gradually superseded by the statutes and ordinances made in parliament. During the reigns of Henry III. and Edward I. laws were promulgated in both forms; but since that time statutes and ordinances have been the only records of legislation—not differing materially, at first, either in form or in the nature of the authority from which they emanated, from the charters of earlier reigns, but gradually assuming their present character as acts agreed to by the entire legislature.

But notwithstanding the discontinuance of the practice of promulgating general laws by royal charter to bind the whole kingdom, the exercise of prerogative, by means of charters, has partaken of a legislative character throughout the entire history of the British government. Some of the most ancient and important of these were charters to boroughs and municipal bodies, conferring immunities and franchises, of which the greatest was that of sending representatives to parliament. There are still extant municipal charters of the Saxon kings, and of the Norman kings after the Conquest, conferring various rights upon the inhabitants of boroughs, of which an exclusive jurisdiction was always one; but the first charter of incorporation to any municipal body appears to have been granted in 1439, in the reign of Henry VI., to Kingston-upon-Hull; although, in the absence of prior charters, it has been usual to presume that charters confirming existing usages had been lost.

Between the reigns of Henry VIII. and Charles II. no less than 180 members were added to the House of Commons by royal charter, the last borough upon which that right was conferred in this manner having been Newark, in 1673. Several of these were ancient boroughs which had ceased to send members, and whose rights were thus restored by charter; while some towns, expressly created boroughs by charter, did not send members to parliament for centuries afterwards, as Queenborough, for example, to which a charter was granted in 1368, but which did not return members until 1578. Hence it has been argued that, notwithstanding the practice of later reigns, the charter of the crown alone was not sufficient in law to entitle a *town* to send members to parliament, although expressly created a borough, to which, by the common law, the right of sending members was incident. This view derives confirmation from the acknowledged law that the crown was unable, by charter, to exempt a borough from returning members, since that right was always held to be exercised for the benefit of the whole realm, and not for the advantage of the particular place. Upon these grounds, a charter of exemption to the citizens of York was declared void by Act of Parliament, 29 Henry VI. c. 3. But as parliamentary representation, after having been made the subject of legislation by parliament under Henry VIII., has now been comprehensively arranged for the whole kingdom by Statute, the legal effect of royal charters upon the elective franchise has become a question merely of historical interest. The peculiar rights of corporations have also been determined by the Municipal Corporations Act (5 & 6 Will. IV. c. 76), which has since its passing been amended by a long series of statutes. A power is reserved to the crown, with the advice of the privy council, to grant charters of incorporation to other towns, upon the petition of the inhabitants, and to extend to them the provisions of the Act.

Charters were formerly granted by the crown which established monopolies in the buying, selling, making, working, or using certain things; an injurious practice, contrary to the ancient and fundamental laws of the realm, which was abolished by 21 James I. c. 3. [Monopoly.]

The crown has ever exercised, and still retains, the prerogative of incorporating universities, colleges, companies, and other public bodies, and of granting them, by charter, powers and privileges not inconsistent with the common law. But as the most considerable bodies ordinarily require powers which no authority but that of parliament is able to confer, such corporations as the East India Company and the Bank of England, which were originally established by royal charter, have long since derived their extraordinary privileges from Acts of Parliament, as well as other public companies which have been incorporated in the first instance by statute.

But the largest powers now conferred by royal charter are those connected with the colonies and foreign possessions of the crown. Whenever a new country is obtained by conquest or treaty, the crown possesses an exclusive prerogative power over it, and by royal charters may establish its laws and the form of its government; may erect courts of justice, of civil and criminal jurisdiction, and otherwise provide for its municipal order, for raising its revenue, and the regulation of its commerce. This power of the crown, however, is always subject, through the responsibility of ministers, to the ultimate control

of parliament; and if once deputed to a legislative assembly or other local government, possessing rights and liberties defined by charter, cannot be recalled.

2. Charters of private persons are the title-deeds of lands, many of which are the ancient grants of feudal lords to their tenants. These pass with the land as incident thereto, and belong to him who has the inheritance, or, if the land be conveyed to another and his heirs, the charters belong to the feoffee. A charter of the crown, granted at the suit of the grantee, is construed most beneficially for the crown, and against the party; but a private charter is construed most strongly against the grantor.

CHARTER-HOUSE, London. Sir Walter de Manny, knight, a stranger born, lord of the town of Manny, in the diocese of Cambray, in the Netherlands, who for services rendered to King Edward III. was made one of the first knights of the order of the garter, in the year of the great plague, 1349, bought a piece of ground without the bar of West Smithfield, which he inclosed and had consecrated for the burial of the dead, and where, in that year alone, more than 50,000 bodies are said to have been interred. It was thereupon called the New Church-Hawe, and a chapel was built, wherein, about the year 1360, Sir Walter de Manny intended to found a college for a warden or dean and twelve secular priests; but in the next year that design was altered, when Michael de Northburgh, bishop of London, joined with him in the building and endowing a priory in this place for double the number of Carthusian monks, which was to be called "The Salutation of the Mother of God," and the foundation appears to have been finished about 1370. The gross revenue of this house at its surrender to King Henry VIII., June 10, 1535, amounted to 736*l.* 2*s.* 7*d.*, its clear income to 642*l.* 0*s.* 4½*d.* per annum. Bearcroft, in his 'Historical Account,' says the site of this house was first granted June 12, 1542, to John Bridges and Thomas Hale, for their joint lives; and April 14, 1555, to Sir Edward North, who was made a baron, 1st Mariæ: his son, Roger Lord North, sold it May 31, 1565, to the duke of Norfolk, for 2500*l.*, whose son, Thomas Howard, earl of Suffolk, sold it in the 9th Jac. I., to Thomas Sutton, Esq., for 13,000*l.*, who founded upon it, and largely endowed, a most magnificent hospital, consisting of a master, preacher, a head schoolmaster, a second master, with forty-four boys and eighty decayed gentlemen, who have been soldiers or merchants, besides a physician, chirurgeons, registrar, and other officers and servants of the house. Besides the scholars upon the foundation, whose number is now limited to forty-two, the masters are allowed to receive certain others, whose number fluctuates from one to two hundred. The Charter-House is considered one of the first schools of the metropolis. Among the eminent persons who have received their education there, may be enumerated Dr. Isaac Barrow, the mathematician; Addison; Steele; Dr. Benson, bishop of Gloucester; Sir William Blackstone; the Rev. Dr. Charles Burney; and the late Sir Henry Havelock.

The Charter-House, no doubt, derives its name from a corruption of *chartreux*, a monastery of Carthusians. The persecution of certain monks of this house forms a striking feature in the history of the Reformation of the time of Henry VIII.

(See Dugdale's *Monasticon*, new edit., vol. vi.. p. 6; Tanner's *Notit. Monast.*, edit. Nasmith, *Midd.* viii., 3; Bearcroft's *Hist. Account of Thomas Sutton, Esq.*, 8vo, Lond,, 1737.)

CHARTER-PARTY. [SHIPS.]

CHARTISTS, the name given to a political party in this country, who propose extensive alterations in the representative system, as the most direct means of attaining social improvement, and whose views are developed in a document called the "People's Charter." The principal points of this proposed charter are, universal suffrage, vote by ballot, annual parliaments, the division of the country into equal electoral districts, the abolition of property qualification in members and paying them for their services. The principles of the charter and the means of carrying them into effect have also been embodied in the form of a bill. It was prepared in 1838, by six members of the House of Commons and six members of the London Working Men's Association; and the following are the most important of its enactments: I. The preparers of the Bill allege the low state of public feeling as an apology for not admitting women to the franchise, and it is therefore only provided that every male inhabitant be entitled to vote for the election of a member of the Commons' House of Parliament, subject however to the following conditions: 1. That he be a native of these realms, or a foreigner who has lived in this country upwards of two years, and has been naturalised. 2. That he be twenty-one years of age 3. That he be not proved insane when the lists of voters are revised. 4. That he be not convicted of felony within six months from and after the passing of this Act. 5. That his electoral rights be not suspended for bribery at elections, or for personation, or for forgery of election certificates, according to the penalties of this Act. II. That the United Kingdom be divided into 300 electoral districts, so as to give uniform constituencies of about 20,000 voters each. III. That the votes be taken by ballot. IV. That a new parliament be elected annually; that the elections take place on the same day in all the districts; and that electors vote only for the representative of the district in which they are registered. V. That no other qualification be required for members than the choice of the electors. VI. That every member be paid 500*l.* a year out of the public treasury for his legislative services; and that a register be kept of the daily attendance of each member.

There is nothing new in the principles or details of the People's Charter. They have either separately, or some one or other of them in conjunction, been a prominent subject of discussion at various intervals within the last eighty years. In 1780 the Duke of Richmond introduced a bill into the House of Lords for annual parliaments and universal suffrage. In the same year the electors of Westminster appointed a committee to take into consideration the election of members of the House of Commons, and in their report they recommend the identical points which now constitute the main features of what is called the People's Charter. The Society of the Friends of the People, established in 1792, three years afterwards published a declaration which recommended a very large extension of the suffrage. In seasons of national distress, the amendment of the representative system has always been warmly taken up by the people of this country.

In 1831 the wishes of a large mass of the middle classes were realised by the passing of the Reform Act. A season of political repose, and, as it happened also, of commercial prosperity, followed the excitement which preceded the passing of that measure. A victory had been gained, and the people waited for the benefits which they were to derive from it. In the next period of distress which arose, the amended state of the representative system and the advantages which it had brought were narrowly scanned; and the consequence was, the gradual formation of a party who were dissatisfied with its arrangements, and sought to attain the ends of political and social good by a more extensive change. This is briefly the origin of Chartism and of the People's Charter. The middle classes were, however, well satisfied on the whole with the overthrow of the rotten boroughs and the enfranchisement of the large towns, and therefore the Chartists stood alone, and began to regard them with a feeling of hostility. Chartists were sometimes found, as in all other parties, ready to assist the party which differed most widely from them, with the object of thwarting the political objects which the middle classes had at heart. In 1838 they had become a large party and embraced a great number of the working classes employed otherwise than in agriculture. The number of signatures attached to the petition presented at the commencement of the session of 1839 in favour of the People's Charter was upwards of one million and a quarter. Unfortunately the idea began to be entertained amongst a certain class of the Chartists that physical force might be justifiably resorted to if necessary for obtaining political changes; and the party became divided into the Physical Force Chartists and the Moral Force Chartists. The former became implicated in disturbances which took place at various times in several parts of the country; and many persons of this class never having had correct views respecting the wages of labour, it appeared as if they had adopted the cry of "a fair day's wages for a fair day's work" as an additional point of the People's Charter. The disturbances in 1842 in the midland and northern counties were to some extent encouraged by the less intelligent of the Physical Force Chartists. At the close of 1841 however an attempt was made to combine the middle classes with the Chartists in their attempt to obtain an extension of the suffrage. Early in 1842 a Complete Suffrage Union was formed at Birmingham: and in April of the same year a conference, consisting of eighty-seven delegates, was assembled at Birmingham, which sat for four days; three of which were spent in agreeing upon a basis of union between the middle and working classes, and the last day in adopting plans of practical organisation. The six points of the People's Charter were adopted by the conference, and the details were left for settlement to a future conference. It was resolved also at this conference to establish a National Complete Suffrage Union. The proposed National Conference commenced its meetings in December, 1842, and was attended by 374 delegates. Here a rupture took place between the Chartists and the Complete Suffrage party, and the latter were outvoted on the question of adopting the People's Charter instead of the Complete Suffrage Bill. The minority however proceeded to act upon their views as developed in the Complete Suffrage Bill. This bill does not contain any disqualifying clauses. In other respects it differs from the People's Charter only in matters of detail. The Chartists and the Complete Suffragists are only nominally distinct parties; and the former are now almost extinct as a party, having merged into the Complete Suffrage party, which however has some unimportant subdivisions.

CHASE, that part of a gun which is between the ring near the trunnions, and the astragal mouldings near the muzzle.

CHASING OF METALS. The process termed chasing, or enchasing, as applied to working in metals, so far resembles a kind of stamping as to admit of the two processes being described here together.

Metallic goods are generally made in one of three ways—by casting in moulds, by forging or turning in masses, or by pressing or stamping out of thin sheets. The last of these three has been greatly developed at Birmingham within the last few years. Either the entire article receives its form from the sheet by stamping, or, when roughly formed, it receives an ornamental device by the action of fine punches. For the latter variety of work, steel blocks, punches, or bosses, are provided, each one presenting at the end a definite form, such as curved, angular, square, &c.; and these are fixed or held with the finished end

uppermost. The article to be ornamented, which is always of a thin hollow kind, is placed face uppermost on the punch; a pattern or design is drawn on the face of the article, and the adjustment is so made that the punch beneath shall follow the course of the lines in the device. A fine hammer is then employed to strike the piece of thin metal; the effect of which is, that the metal is forced upwards in a fine burr or protuberance at every place where there is a punch beneath it. By shifting the piece of metal so that different parts of its lower surface may in succession be brought over the punch, and by changing the form of the punch when necessary, a protuberant design or pattern in relief is formed on the article of metal. In the finer kinds of metal work greater sharpness, relief, and finish are then given to the design by going over it with very sharp-cutting tools; and it is upon this last part of the process, and which is that technically known as chasing or enchasing, that the artistic character of the work largely depends.

But a more extensive kind of manufacture is that in which the article receives its form by being stamped or pressed from a plain piece of sheet metal. The hammer, the swage, the roller, the stamp, and the lathe are all employed to effect this, according to the thickness of the metal and the nature of the article to be made from it. When vessels and hollow articles are fashioned out of thin sheet-metal by the hammer, it constitutes *brazing:* the metal is rested upon bosses or steel supports of different kinds, and hammered on the upper surface till it assumes the requisite curvatures. The swage is a peculiar kind of gauge or pattern which gives the requisite form to the sheet metal by pressure rather than by percussion. Let us suppose (as a familiar mode of illustrating its action) that a pair of scissors has the two blades so curved that the convexity of the one may fit into or correspond with the concavity of the other; if these blades were nearly closed, and a thin piece of metal were drawn between them, it would be forced into a curved form similar to that presented by the blades. The arrangement of the different parts of the swage is so managed as to lead to some such result as that here indicated. The beadings and hollows on the edges of dish-covers and similar articles are produced by means of swages.

Many articles, such as large plain hollow vessels, are brought into form mainly by rollers. Tinsmiths often employ three rollers to bring their tin to the proper form for tubes and cylindrical vessels. There are two rollers placed nearly in contact, and in the same horizontal level; another is placed above them, equidistant from both; all are capable of revolving, and if a piece of tinned iron be drawn between them, it will be forced to conform to the size and shape of the cavity existing between the upper and the lower rollers: by varying the sizes and mutual distances of the rollers, different curvatures of the tin may be produced.

The lathe is employed in rather a singular way, in the production of various kinds of articles from thin sheet-metal, principally from soft white yielding alloys of tin and other metals. A flat circular disc of metal can by this means be brought to the shape of a cylindrical box, a cup, a hemisphere, or any one among numerous fanciful forms. The disc is attached to a lathe provided with a boss or block of the required shape, and a blunt tool is pressed against it while revolving; the soft and ductile metal yields to the pressure and conforms to the shape of the boss against which it is placed. By little and little the workman effects the transformation of the flat piece of metal to a shape which it could not assume unless it were soft and ductile. Teapots and other articles of Britannia metal are largely produced by this process, which is called "spinning."

The most important however of these modes of working sheet-metal is by stamping. In this process the thin metal is suddenly and very forcibly compressed between two steel dies or stamps, each of which is engraved with a pattern or device. One die is fixed on a stand with its face uppermost, while the other is fixed face downwards to the lower end of a heavy hammer or weight. The thin piece of metal is placed on the lower die; the hammer with the upper die is raised by a rope and pulley to a considerable height, and on this being allowed suddenly to fall, the upper die forcibly compresses the thin piece of metal which lies between it and the lower, compelling it to assume alternate convexities and concavities according to the pattern. Each die is an exact counterpart or reverse of the other, like the two halves of a swage, so that the metal cannot conform to the convexity of the one without falling into the concavity of the other; and it is by this double action that the result is produced. Spoons, forks, and trinkets in numberless variety are produced by stamping between two dies modified in various ways according to the particular object in view.

This mode of stamping requires as many dies as there are different patterns. The late Dr. Ure, in illustration of the heavy stock which the manufacturers at Birmingham are thus forced to keep by them, and of a difference in this respect between them and the French manufacturers, remarked: "M. Parquin, the greatest manufacturer of plated goods in Paris (or France, for this business is monopolised by the capital), who makes to the value of 700,000 francs per annum, out of the 1,500,000 which he says is the whole internal consumption of the kingdom, states that the internal consumption of the United Kingdom amounts to 30,000,000, or twenty times that of France. He adds that our common laminated copper costs 26 sous the pound, while theirs costs 34. Their plated goods are fashioned not in general with stamps, but by the pressure of tools upon wood moulds in the turning-lathe, which is a great economy of capital to the manufacturer." This "pressure of tools upon wood moulds in the turning-lathe" corresponds with one of the processes above described, namely, the "spinning." It is believed that four of the establishments at Birmingham keep in stock more than a quarter of a million of different die-moulds for stamping the almost innumerable articles now made of thin brass, &c., in that busy centre of the metal trades.

For different applications of the above processes to manufactures, see BUTTON, and COINING; for the mode of making the dies, DIE-SINKING; and for stamping in connection with electro-gilding and silvering, ELECTRO-METALLURGY.

CHÂTELET, or CHASTELET, properly a little fortress. This name was afterwards given to certain courts of justice, formerly established in several cities of France, as at Orléans, Montpellier, &c. Le Grand Châtelet, at Paris, was the place where the presidial and ordinary court of justice of the provost of Paris was held. Le Petit Châtelet, at Paris, answered to its proper name; it was an ancient fort, serving as a prison. (Furetière, *Diction. Universelle,* 'Châtelet.')

CHATTELS (*Catalla*). This term comprehends all property, moveable or immoveable, which is not freehold. Those chattels are called chattels real which, in the language of the earlier law writers, savour of the reality; that is, relate to, or are interests in land. Chattels personal are moveable goods, as horses, plate, money, &c. A lease is a chattel real. Chattels of each description pass to the personal representatives of the deceased proprietor, and are comprehended under the general term "personal property." The laws which govern this description of property are now, from the growth of the mercantile system and the change of manners, equal in importance with those relating to real estate; but under the feudal system, chattels (including even terms for years) were considered of small importance in a legal point of view; and, indeed, prior to the reign of Henry VI., were rarely mentioned in the law treatises and reports of the day. (Reeve's 'Hist. Eng. Law,' 369.) Many articles of property, intrinsically chattels, from their intimate connection with other property of a freehold nature, and being necessary to its enjoyment, descend therewith to the heir, and are not treated as chattels. Thus, for instance, the muniments of title to an estate of inheritance, growing trees and grass, deer in a park, and such fixtures as cannot be removed from the freehold without injury to it, are not chattels, because they pass to the heir. In the hands of a person however who has a limited interest in such things, they become his chattels, and pass to his executor. Chattels, except so far as they may be impressed with the nature of heir-looms, cannot be entailed, but they may be limited to trustees so as to vest in successive owners for life, and in unborn persons in fee, precisely as an estate-tail. They do not go in succession to a corporation sole, except only in the cases of the king and the chamberlain of the city of London. (Co. Litt.; Blackst., *Comm.,* Mr. Kerr's ed., vol. ii., pp. 393, 406, 438.)

CHAUCI, a nation of ancient Germany, who lived north-east of the Frisii, along the coast of the North Sea, on both banks of the Visurgis (Weser), and as far as the Albis, or Elbe. To the south they bordered upon the Catti. Their territories pretty nearly corresponded to the present Hanover and Oldenburg. Tacitus ('Germania,' 35) says that their country was extensive and thickly inhabited, and that they were a people distinguished among the Germans for their love of justice and of peace; powerful and yet unambitious, they did not provoke war, but were always ready to resist aggression. They were subdued by Tiberius, and continued for some time friends to Rome, furnishing auxiliaries to Germanicus in the war against the Cherusci. ('Annal.,' i. 60, ii. 17.) They were celebrated as navigators and pirates; and when under Claudius, they were driven by oppression into rebellion, the Chauci, under Gannascus, a chief of the Batavian tribe of the Cannine-fates, ravaged the coast of Gaul, and crossed the Rhine to make incursions into the Roman province of Germania Inferior; but they were defeated by Corbulo, who, however, failed in subjugating them, and they continued independent of Rome. ('Annal.,' xi. 18.) They afterwards joined in the revolt of the Batavian chief Civilis. ('Histor.,' iv. 79, v. 19.) The Chauci are last mentioned under the reign of Didius Julianus, when they belonged to the confederacy of the Saxons, and are said to have extended their territories to the banks of the Rhine.

CHECK, a species of checkered cloth, in which coloured lines or stripes cross each other rectangularly, like a chess-board. This manner of beautifying webs is probably very ancient. Many of the figures in Rosellini's Egyptian work are dressed in checkered cloths. Bishop Anselm's book concerning 'Virginity,' written about the year 680, when the art of weaving in this country was probably in a comparatively rude state, contains a distinct indication that checkered robes were then in fashion: "It is not a web of one uniform colour and texture, without any variety of figures that pleaseth the eye and appeareth beautiful, but one that is woven by shuttles, filled with threads of purple, and many other colours flying from side to side, and forming a variety of figures and images in different compartments with admirable art." These compartments, defined and bounded by coloured threads, may reasonably be regarded as checks; nevertheless, it is well to admit that other kinds of woven material would sufficiently answer to Anselm's description.

As manufactured at the present day, checks are sometimes pro

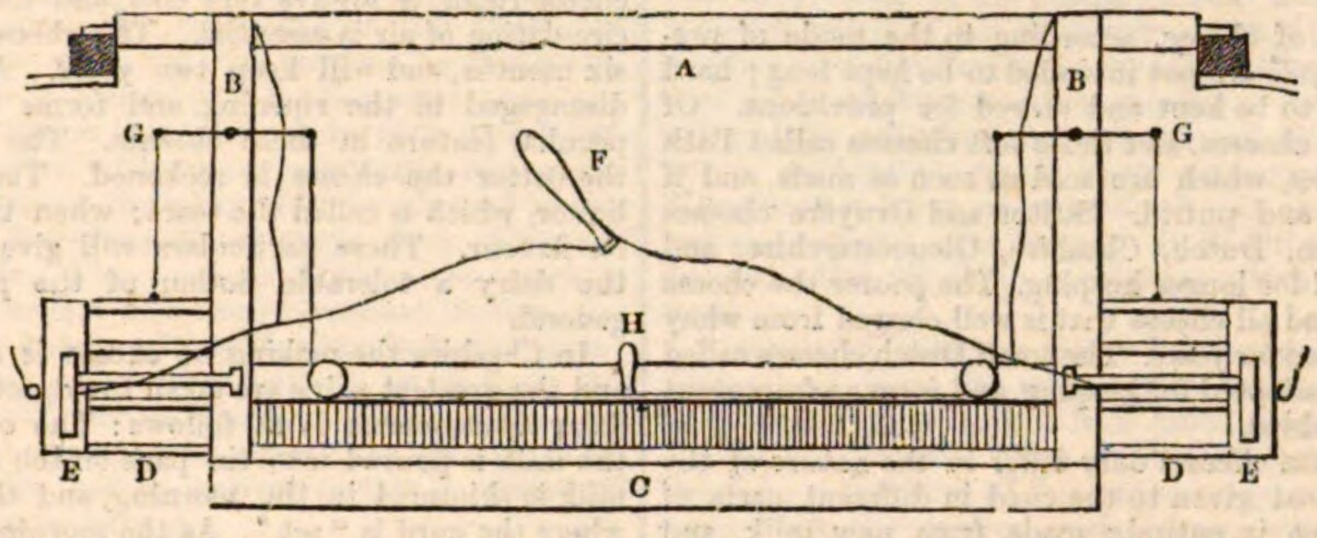
duced not by differently coloured threads, but by threads of different fineness and quality. Thus, if the chain, warp, or longitudinal yarns of the web be composed of alternate parcels of white cotton and woollen threads, and the transverse yarns, or the woof, be also composed of such alternate parcels, we shall have a check very distinctly brought forth without any distinction of colour, properly so called.

Cotton handkerchiefs checked of various colours have been manufactured in India probably from time immemorial under the name of *pullicates*. They were first imported into this country from Madras, whence they derived the name by which this style is still known in the trade,—there being a town of Pulicat or Pullicate a few miles north of Madras. The ground of these has usually a pale buff colour, and is

woven with the nankin yellow cotton. Checks in this country are mostly manufactured for the coarser purposes of seamen's shirts, aprons, and bedgowns of females in the lower ranks of life. The quantity required is so great as to make it a very important branch of business, and to render every mechanism which facilitates the fabrication an object of consequence. Blackburn in England, and Kirkaldy in Scotland, are the two chief seats of the check trade; the former in cotton, and the latter, till of late years, chiefly in linen yarns.

For the decussation or weaving of woof yarns of different kinds or colours in one web, different shuttles must be in readiness for alternate use. The mode in which this is effected is shown by the figure.

Here we see the picking peg (F), which the weaver seizes in his right



hand, and with a dexterous jerk causes one of the shuttles lodged in the separate cells at DD to move from one side of the loom to the other across the line of the warp, by means of the string which extends from that peg to the drivers or peckers (EE) seen at the end of the cells. The three shuttle-boxes here shown, are so constructed as to be made to slide up and down in a vertical plane, so that each box with its appropriate shuttle may at pleasure be brought on a level with the shuttle-race, or open shedding of the warp, and thus be thrown across. These three boxes are suspended by cords from the cross levers (GG), which turn upon centres, in the suspending bars marked BB, or the swords of the lay, being the levers which make it vibrate backwards and forwards in the act of weaving: A represents the cross-bar of wood on which the lay C oscillates upon iron gudgeons, or pins driven into each of its ends, and resting upon the upper rails of the loom, as shown in section. The under part of the lay is seen at C, and the upper part, called the lay-cap (H), is seized by the weaver's left hand in driving home each shute or shoot of weft. The two pieces of buffalo hide called the drivers or peckers (EE) are perforated, and traverse or slide horizontally upon smoothly polished iron rods. These pieces give the immediate impulsion to the shuttle. The weavers' twitch at the picking peg H must be sufficiently smart to communicate adequate velocity to the shuttle, so as to lodge it in the opposite box, and overcome its friction along the warp-race; on the other hand, he must avoid giving it too forcible a pull, which might do injury to its point, or throw it out of the shed. The pin H is made to slide freely from right to left upon the upper bar of the lay, and thus give such motion to the levers (GG) as may bring the proper box opposite to the shuttle-driver.

As diversity of woof renders diversity of shuttles necessary, it becomes expedient to shift them rapidly, otherwise the operation would be much impeded. The above plan is not the one originally employed, but is in many respects better. The pin (H) being fixed by friction only, so as to slide from right to left on the upper shell of the lay, the levers (GG) connected with it may be readily moved, being within reach of the weaver's hand, as he works the lay. The driver, if drawn forward, would present an obstruction to the shifting of the boxes, but this may be easily avoided by an experienced operative.

Mr. Robert Kay, of Bury, son of the most ingenious but persecuted inventor of the fly-shuttle, invented the above-described drop-box, for making checks; by means of which, as we see, the weaver could at pleasure use any one of three shuttles without rising from his seat, each shuttle containing a differently coloured weft.

The relation which this production of checks bears to other departments of textile manufacture will be further illustrated under WEAVING.

CHEESE. [CASEIN.]

CHEESE. The milk of animals consists of three distinct substances, which are separated from one another by a slight change, which begins as soon as it is exposed to the air. The oily part rises to the surface by its less specific gravity, and when it is collected into a solid mass by agitation it forms butter; the curd, coagulated by the action of any acid, and pressed, becomes cheese; and the fluid which remains is the serum or whey.

In the making of cheese there are certain general principles which are essential, but slight variations in the process produce cheeses of very different qualities; and, although a very important circumstance is the nature of the pasture on which the cows are fed, yet much depends on the mode in which in its different stages the fabrication is managed; and hence the great superiority of the cheeses of particular districts or dairies over those of others, without any apparent difference in the pasture. By skill and great attention excellent cheeses are made in places where the pastures are not considered so well adapted to produce milk of a proper quality; and in those countries where the cows are chiefly kept tied up in stalls, and are fed with a variety of natural and artificial grasses, roots, and vegetables, superior cheese is often made.

The first process in making cheese is to separate the curd from the whey: this may be done by allowing the milk to become sour; but the cheese is then inferior in quality, and it is difficult to stop the acid fermentation, and prevent its running into the putrefactive. Various substances added to milk will soon separate the curd from the whey. All acids curdle milk. Muriatic acid is used with success for this purpose in Holland. Some vegetables contain acids which readily coagulate milk, such as the juice of the fig-tree, and the flowers of the *Galium verum*, or yellow lady's bed-straw, hence called *cheese rennet*. Where better rennet cannot be procured, they may be substituted for the most natural curdler of milk, which is the gastric juice of the stomach of a sucking calf. This juice rapidly coagulates the milk as the calf sucks; and the only difficulty is in collecting and keeping it from putrefaction, which begins from the instant the stomach is taken from the calf. The preparation of the *rennet*, as it is called, is a most important part of the process of cheese-making. The following may be considered as the simplest, and perhaps the best: As soon as a sucking calf is killed, the stomach should be taken out, and if the calf has sucked lately, it is all the better. The outer skin should be well scraped, and all fat and useless membranes carefully removed. It is only the inner coat which must be preserved. The coagulated milk should be taken out and examined, and any substance besides curd found in it should be carefully removed. The serum left in it should be pressed out with a cloth. It should then be replaced in the stomach with a large quantity of the best salt. Some add a little alum and sal prunella; others put various herbs and spices, with the view of giving the cheese a peculiar flavour, but the plain simple salting is sufficient. The skins or vells, as they are called, are then put into a pan and covered with a saturated solution of salt, in which they are soaked for some hours; but there must be no more liquor than will well moisten the vells. They are afterwards hung up to dry, a piece of flat wood being put crosswise into each to stretch them out. They should be perfectly dried, and look like parchment. In this state they may be kept in a dry place for any length of time, and are always ready for use. In some places, at the time of making cheese, a piece of a vell is cut off and soaked for some hours in water or whey, and the whole is added to the warm milk. In other places, pieces of vell are put into a linen bag and soaked in warm water, until the water has acquired sufficient strength, which is proved by trying a portion of it in warm milk. The method employed in Switzerland is as follows: A dry vell is taken and examined; it is scraped with a knife, and where any veins or pieces of tough membrane appear, they are removed. The whole surface is examined and washed carefully, if any dust or dirt has adhered to it; but otherwise it is only wiped with a cloth. A handful of salt is then put into it, and the edges of the vell are folded over and secured with a wooden skewer stuck through it. In this state it forms a ball of about three inches diameter, and is laid to soak twenty-four hours in a dish containing about a quart of clear whey, which has been boiled, and all the curd taken out. The next day the vell is well squeezed, and put into fresh whey; the first infusion being put into a proper vessel, the second is afterwards mixed with it, and bottled for use. Half a pint of this liquor, of a proper strength, is sufficient to curdle forty gallons of milk. Experience alone enables the dairyman to judge of the strength of his rennet; for this purpose he takes in a

flat ladle some milk which has been heated to about 95° of Fahrenheit, and adds a small measure of rennet; by the rapidity with which it curdles, and the form of the flakes produced, he knows its exact strength and puts more or less into the caldron in which the milk is heated for curdling. A simple instrument might be easily invented, by which the exact degree of strength might be ascertained, and a rule given to guide the less experienced; but as long as a man feels a superiority acquired by experience alone, he is not likely to encourage any contrivance which would place others on a level with himself. From this cause even the thermometer has not been introduced generally into any great dairy, nor have any certain rules been given to ascertain the exact heat required in the milk, when the rennet is added, to form the best curd.

There are different kinds of cheese, according to the mode of preparing it: soft and rich cheeses are not intended to be kept long; hard and dry cheeses are adapted to be kept and stored for provisions. Of the first kind are all cream cheeses, and those soft cheeses called Bath cheeses and Yorkshire cheeses, which are sold as soon as made, and if kept too long become soft and putrid. Stilton and Gruyère cheeses are intermediate; Parmesan, Dutch, Cheshire, Gloucestershire, and similar cheeses, are intended for longer keeping. The poorer the cheese is the longer it will keep; and all cheese that is well cleared from whey and sufficiently salted will keep for years. The small Dutch cheeses called Edam cheeses are admirably adapted for keeping, and form an fmportant article in the victualling of ships.

The Gruyère and Parmesan cheeses only differ in the nature of the milk, and in the degree of heat given to the curd in different parts of the process. Gruyère cheese is entirely made from new milk, and Parmesan from skimmed milk. In the first nothing is added to give flavour; in the latter saffron gives both colour and flavour: the process in both is exactly similar. A large caldron in the shape of a bell, capable of holding from 60 to 120 gallons of milk, hangs from an iron crane over a hearth where a wood fire is made. The milk, having been strained, is put into this caldron, and heated to nearly blood-heat (95° to 100°). It is then turned off the fire, and some rennet, prepared as stated above, is intimately mixed with the warm milk by stirring it with the hand, in which is held a flat wooden skimming-dish, which is turned round in the milk while the hand and arm stir it. A cloth is then laid over the caldron, and in half an hour, more or less, the coagulum is formed. This is ascertained by pressing the skimming-dish on the surface, when the whey will appear on the part pressed. If it is longer than an hour in coagulating, the milk has been too cool or the rennet not strong enough. The weather has a great influence on the process of the dairy, and there is much yet to be learned by accurate observations with meteorological instruments, especially electrometers. When the curd is properly formed, it is cut horizontally in thin slices by the same skimming-ladle. Each slice, as it is taken off, is poured along the side of the caldron which is nearest to the operator; by this means every portion of the curd rises successively to the surface, and is sliced thin. The whole is then well stirred, and the caldron is replaced over the fire. A long staff, with a small knob of hard wood at the end, and which has smaller cross pieces or sticks passed through holes in it at right angles to each other near the end, is now used to stir and break the curd, and the heat is raised to about 135°, which is as hot as the arm can well bear, even when used to it. The caldron is again swung off the fire, and the curd is stirred with the staff, which is moved round with a regular rotatory motion, the knob running along the angle formed with the side by the bottom of the caldron, which is in the form of a bowl. After stirring in this manner nearly an hour, the curd is found divided into small dice about the size of a pea, which feel elastic and rather tough under the finger. Experience alone can teach the exact feel they should have. The whey, of which a portion is removed occasionally, now floats at top, and the curd is collected in the bottom by giving a very rapid rotatory motion to the contents of the caldron by means of the staff. A cloth is now introduced into the bottom, and all the curd collected over it; it is raised by the four corners, and laid on an instrument like a small ladder, which is placed across the mouth of the caldron. The whey runs out through the cloth, which is a common cheese-cloth, woven with wide interstices; and the curd in the cloth is placed in a shape or hoop made of a slip of wood four inches and a half wide, the two ends of which lie over each other, so that the diameter can be increased or lessened. A cord fixed to one end of the hoop is passed with a loop over hooks on the outer surface of the other end, and prevents the ring from opening more than is required. The curd is pressed into this ring with the hands, and the ends of the cloth are folded over it. A round board, two inches thick, and strengthened by cross pieces nailed on it, is placed over the curd, and the press let down upon it.

The cheese-press is a simple long board or frame forming a lever, loaded at one end and moving in a frame at the other; it is lifted up by another lever connected with it, and let down on a strong stick, which stands with its end on the centre of the board last-mentioned. Thus the weight is easily removed or replaced. The hoop containing the cheese is placed on a similar board, and from it the table of the press slopes towards a wooden trough, which receives the whey as it runs out. In an hour after this, the curd is examined; the edges, which are pressed over the ring, are pared off, and the parings are put

on the centre of the cheese; a fresh cloth is substituted, and the whole cheese is turned. The ring, which opens readily by unhooking the cord, allows the cheese to come out, and is put on again and tightened. This is repeated two or three times in the day. In the evening, a small portion of finely powdered salt is rubbed on each side of the cheese, and it remains in the press till the next morning. It is now again rubbed with salt, and placed on a shelf with a loose board under it. The wooden ring remains on the cheese for two or three days, and is then taken off. This is the whole process.

During the next six or eight weeks, the cheeses are turned and wiped every day, and a small quantity of fine salt is sifted on the surface and rubbed in with the hand until it will take no more. The cheese-room is always very cool, and little light is admitted. A free circulation of air is essential. The cheeses are in perfection in about six months, and will keep two years. A quantity of elastic fluid is disengaged in the ripening, and forms those round eyes which are a peculiar feature in these cheeses. The smaller and rounder the eyes, the better the cheese is reckoned. They should contain a clear salt liquor, which is called the tears; when these dry up, the cheese loses its flavour. These particulars will give any one unacquainted with the dairy a tolerable notion of the process of cheese-making in general.

In Cheshire the making of cheese is carried on in great perfection, and the greatest pains are taken to extract every particle of whey. The dairy management is as follows: The cows are milked at night, and the milk is poured into tin pans on the floor of the milk-house. This milk is skimmed in the morning, and then poured into the large tub where the curd is "set." As the morning's milking proceeds, the pails full are brought one after another and poured into this tub. A pan of milk is warmed in a boiler in the dairy, and when sufficiently hot the cream just taken from the evening's milk is mixed with it, and the whole thus warmed is poured at last into the tub which thus contains the whole milk, cream and all, of both "meals." The colouring matter, "annatto," apparently about a gill, is added to the 100 or 120 gallons which may be then in the tub as the produce of 48 to 50 cows; a half handful of saltpetre is thrown in with the view of correcting the bitterness which is to be detected while the butter-cups are in full leaf; and the rennet, about a pint of brine in which two or three little bits of the prepared vells or "bag skins" have been steeped over night, is added to the milk, which is then left for an hour covered up till the curd has fully formed. It is then cut slowly with a wire curd breaker, and the curd sinking, the whey is baled out; the curd is collected and squeezed both by hand and by the direct pressure of a weight above a board placed upon it, and the last of the whey being removed it is lifted into one of the large Cheshire cheese vats pierced with holes for the further escape of fluid; the lower part being a wooden cylindrical vat, and the upper a tinned cylinder slipping into it as the curd on pressure sinks. After a certain pressure in this *form*, the curd is removed and cut and broken by hand, and from 1 to 2 lbs. of fine salt is scattered over it, and the whole rebroken and refilled into the vat, into which a cheese cloth has previously been placed. There it remains for the day, yielding somewhat to the pressure of its own weight. It is then put gradually under pressure, which on the second or third day amounts to nearly a ton weight upon each cheese.

Every day the cheese is turned and wrapped in fresh cloths, and on the seventh or eighth day of this treatment, or as soon as dry, it is removed to the loft and there, swathed around with strong girthing, placed on a bench. By-and-by it is laid, still swathed as before, on a layer of straw on the floor of the room, and there it lies till from ten weeks to four months old, when it is ready for sale.

This is pretty generally the history of a Cheshire cheese. In some dairies, in order to the perfect extraction of the whey, skewers are used to pierce it, being thrust repeatedly into it through the holes in the cheese vat, in order to the formation of drains for the liquid. The whey is heated in a boiler, and throws up a cream, called "fleetings," which is skimmed twice, the first yielding a very good butter, and the latter a substance used principally for feeding calves; the whey is afterwards given to the pigs. Excepting a portion of the cream from the milk used in the house, and that which thus comes from the whey, the Cheshire cheese is a whole-milk cheese, and as rich, therefore, as any that is made.

Gloucester and Somersetshire cheeses are similarly made, with this difference, that the curd is not so often broken or the cheese skewered, and a portion of the cream is generally abstracted to make butter. After the curd has been separated from the whey and is broken fine, a little warm water is sometimes poured over it for the purpose of washing out any remaining whey, or perhaps to dissolve any portion of butter which may have separated before the rennet had coagulated the milk; for although cream adds to the richness of cheese, butter tends to make it rancid. This practice is, however, both lazy and mischievous, inasmuch as it impoverishes the curd. Gloucester cheeses, too, are not so heavy as Cheshire, or as Cheddar and other Somerset cheeses.

Stilton cheese is made by adding the cream of the preceding evening's milk to the morning's milking. The cream should be intimately incorporated with the new milk; great attention should be paid to the temperature of both, and much of the quality of the cheese depends on this part of the process. To make this cheese in perfection, as

much depends on the management of the cheese after it is made as on the richness of the milk. Each dairy-woman has some peculiar method which she considers as the best; and it is certain that there is the greatest difference between cheeses made in contiguous dairies. The rennet should be very pure and sweet. When the milk is coagulated, the whole curd is taken out, drained on a sieve, and very moderately pressed. It is then put into a shape in the form of a cylinder, eight or nine inches in diameter, the axis of which is longer than the diameter of the base. When it is sufficiently firm, a cloth or tape is wound round it to prevent its breaking, and it is set on a shelf. It is occasionally powdered with flour, and plunged into hot water. This hardens the outer coat and favours the internal fermentation, which ripens it. Stilton cheese is generally preferred when a green mould appears in its texture. To accelerate this, pieces of a mouldy cheese are sometimes inserted into holes made for the purpose by the scoop, called a *taster*, and wine or ale is poured over for the same purpose; but the best cheeses do not require this, and are in perfection when the inside becomes soft like butter, without any appearance of mouldiness. In making very rich cheeses the whey must be allowed to run off slowly, because, if it were forced rapidly, it might carry off a great portion of the fat of the cheese. This happens more or less in every mode of making cheese. To collect this superabundant butter, the whey is set in shallow pans, as is done with milk when butter is made; and an inferior kind of butter called *whey butter* is made from the cream or fat skimmed off. Keevil's cheese-making machine, which cuts by the slow revolution of a framework of wires through the curd, separates the whey so gradually that no buttery matter is carried off with it, and no whey butter can be formed.

Cheeses are frequently coloured, a practice which probably arose from the notion of making the cheese look richer; but now it deceives no one. Yet if some cheeses were not coloured, they would not be so marketable, owing to the association that subsists between the colour and the quality of the cheese. The substance used for colouring is most commonly arnotto. [ARNOTTO.] It is ground fine on a stone, and mixed with the milk at the time the rennet is put in. The juice of the orange carrot, and flower of the marygold, are also used for this purpose. This last give a more natural tint than the arnotto, which is too red. Cheddar cheese made in Somersetshire, which is highly prized, Stilton, Derby, and some other cheeses, are never coloured: Cheshire slightly: but some dairies in Gloucester and North Wiltshire colour deeply. Foreign cheeses are only coloured very slightly, if at all; the Dutch cheeses are made in a very similar manner to the Gloucester cheeses, but the milk is generally curdled by means of muriatic acid or spirits of salt: and great care is taken to prevent fermentation, and to extract the whole of the whey. For this purpose the curd is repeatedly broken and pressed; and before it is made up into the round shape in which it is usually sold, the broken curd is well soaked in a strong solution of common salt in water. This diffuses the salt throughout the whole mass, and effectually checks fermentation. When the cheeses are finally pressed, all the whey which may remain is washed out with the brine; salt is likewise rubbed over the outside, and they are set to dry on shelves in a cool place. The flavour of the cheese is perhaps impaired by the stoppage of the fermentation; but it never heaves, and it acquires the valuable quality of keeping well even in warm climates. From the place where this cheese is commonly made, it is known by the name of Edam cheese. A finer cheese is made at Gouda and other places, by imitating the process in making Gruyère cheese; but this cheese is always full of small cavities, and will not keep so long as the Edam. The cheese most commonly met with in Holland is a large kind of skim-milk cheese, which is made very like Cheshire cheese. It grows hard and dry, and has not much flavour. To supply this defect, cummin seeds are mixed with the curd, which those who are accustomed to it consider a great improvement. On the whole it is a better cheese than our Suffolk skim-milk cheese, and forms an important part of the provisions usually stored for a Dutch family. In France the Roquefort cheese is compared to our Stilton, but is much inferior, although a good cheese. The little cheeses made from cream and folded in paper, called Neufchâtel cheeses are imported from France as a delicacy. They can be easily imitated, being nothing more than cream thickened by heat, and pressed in a small mould. They undergo a rapid change, first becoming sour and then mellow, in which state they must be eaten.

A small cheese, much relished by all ranks, is made in the north of Germany in the simplest manner. It is usually made from milk from which the cream has been taken off to make butter,—although the entire milk is much better. This is curdled by being placed near a fire. When it has become somewhat sour, it is put into a linen bag, and all the whey well pressed out. When it is tolerably solid, it is broken by the hand in a tub, and made very fine. It remains in this state several days, until a considerable alteration takes place, and the putrid fermentation begins, as is readily perceived by the odour. It is then taken in small portions, and formed into flattened balls three or four inches in diameter, by beating them in the hands. These balls are ranged on a board, and set to dry. A portion of caraway seed is generally mixed with the curd. In a few days the mellowing goes on, and the centre becomes very soft. In this state it is a great dainty for those who disregard a pungent and fetid smell. They are sometimes placed in the smoke of a chimney where the putrid fermentation is checked and confined to the centre by the pyroligneous acid arising from a wood fire. They remain in the chimney a considerable time; and when they are used the outer part is peeled off like the rind of an apple. A whole cheese is a mere mouthful. It gives a relish to the sour black rye bread generally eaten by the lower orders.

The green Swiss cheese, commonly called *Schabzieger*, which is made in the canton of Glarus, and is by many persons highly esteemed, is made somewhat in the same manner. The curd is pressed in boxes with holes to let the whey run out; and when a considerable quantity has been collected and putrefaction begins, it is worked into a paste with a large proportion of a certain dried herb reduced to powder. This herb, called in the country dialect *Zieger kraut* (curd-herb), is the *Melilotus officinalis*, which is very common in most countries, and has a peculiar aromatic flavour in the mountains of Switzerland. The paste thus produced is pressed into moulds of the shape of a common flower-pot, and the putrefaction being stopped by the aromatic herb, it dries into a solid mass, which keeps unchanged for any length of time. When used it is rasped or scraped, and the powder mixed with fresh butter is spread upon bread. It is either much relished or much disliked, like all those substances which have a peculiar taste and smell.

A species of cheese or rather hard curd is made in the mountains of Switzerland from the whey which has run from the common cheese made of the whole milk. It is called *serré*. When the Gruyère or the Jura cheese, which is often sold by the same name, has been put under the press, a quantity of fermented whey, about two or three gallons, is poured into the caldron with the new whey, and the whole is heated over the fire till a thick scum rises. This is taken off when the whey is nearly boiling, and put into a square box with holes in it; the whey which remained mixed with the curd, and which is now very blue, is allowed to run out, and a small pressure assists it. When a cheese of sixty pounds has been made, the serré will often weigh twenty pounds. This mass of curd readily dries on the shelf, and becomes hard. It has little flavour, but it serves the people on the mountains for bread. They cut slices of it, spread some butter over, and put a thin slice of cheese upon this: washed down with a cup of fresh or of fermented whey, it forms the chief food of the mountain herdsmen. The only luxury indulged in is an occasional glass of *kirsch-wasser*, a spirit distilled from cherries, or of gentian brandy, from the root of the *Gentiana officinalis*.

When a cheese which has been much salted and kept very dry is washed several times in soft water, and then laid in a cloth moistened with wine or vinegar, it gradually loses its saltness, and from being hard and dry, becomes soft and mellow, provided it be a rich cheese. This simple method of improving cheese is worth knowing. It is generally practised in Switzerland, where cheeses are kept stored for many years, and if they were not very salt and dry they would soon be the prey of worms and mites. A dry Stilton cheese may thus be much improved.

CHELERYTHRINE. [CHELIDONINE.]

CHELIDONIC ACID ($C_{14}H_4O_{12}+2aq.$) occurs in the same plant as CHELIDONINE, in combination with that and other bases, principally, however, with lime. The lime salt may be obtained from the juice pressed from the fresh plant, best gathered when in full flower. This liquid is boiled, filtered, acidified with nitric acid, and solution of nitrate of lead added so long as a precipitate falls, care being taken not to add excess of nitrate. The washed precipitate still retaining lime is decomposed by passing sulphuretted hydrogen for two or three days through water in which it is suspended; the solution, filtered, is then neutralised with chalk, decolourised with animal charcoal, and evaporated to the crystallising point.

With the *chelidonate of lime* thus produced, combinations of chelidonic acid with almost any of the bases can be conveniently prepared by double decomposition with their neutral and other salts. An interesting class of compounds is thus obtained, containing one, two, or three equivalents of metal in the place of one, two, or three equivalents of hydrogen.

It is not easy to isolate chelidonic acid from its salts. Perhaps the best method is to obtain it from its combination with ammonia, a salt produced by double decomposition of chelidonate of lime and carbonate of ammonia. To a concentrated solution of this compound, twice its volume of strong hydrochloric acid is added. The whole usually sets into a solid mass, from which the chelidonic acid may be finally obtained pure by repeated crystallisation from water.

This acid forms long colourless needles. In the air they slowly effloresce. Heated to 212° Fahr. they lose their two atoms of water of crystallisation, and at a higher temperature decompose. They are soluble to a certain extent in cold water, but very much so in boiling water. They are also dissolved by alcohol.

Chelidonic acid dissolves in concentrated sulphuric acid, without alteration, unless heat is applied, when decomposition quickly occurs. Strong nitric acid acts very slowly upon it; slightly diluted, nitrous fumes are evolved, and an acid produced that has not yet been examined; it is not oxalic acid.

Chelidonic acid dissolves iron or zinc, with disengagement of hydrogen gas.

CHELIDONINE ($C_{40}H_{19}N_3O_6$?). An alkaloid found in the *common*

celandine (*Chelidonium majus*, nat. ord. *Papaveraceæ*). Probst recommends the following process for its preparation:

Exhaust the root with water acidified with sulphuric acid, precipitate the percolate by ammonia, digest the precipitate in alcohol, evaporate the solution to dryness, re-dissolve in water, and again precipitate with ammonia. A mixture of chelidonine and *chelerythrine* will thus be obtained; the latter may be dissolved out with ether, and the former purified by dissolving in a small quantity of very dilute sulphuric acid, and adding about twice as much strong hydrochloric acid. Hydrochlorate of chelidonine then slowly precipitates in granular crystals, from which the alkaloid itself may be obtained by digestion in ammonia.

Crystallised from alcohol, chelidonine presents the appearance of little colourless tables, insoluble in water, soluble in ether. Heated it melts at 266° Fahr., and at a higher temperature decomposes.

Chelidonine is very soluble in acids, combining with them to form salts, which are for the most part crystalline. Their solutions are acid to test-paper, of a bitter taste and more or less decomposed by evaporation. They are said to be devoid of poisonous properties.

CHELIDOXANTHIN. A neutral non-nitrogenous matter found in the same plant as CHELIDONINE. It is precipitated by subacetate of lead from the expressed juice. If the lead precipitate be washed with water and decomposed in the usual way by sulphuretted hydrogen, it is obtained in confused groups of acicular crystals. It has a yellow colour and bitter taste, slightly soluble in cold water, much more so in hot water. Neither acids nor alkalies affect the solution.

CHELTENHAM, WATERS OF. In all the springs which emerge from the sandy vale of Cheltenham, the sulphate of soda or chloride of sodium predominates; so that they belong to the class of saline waters. It is worthy of notice, that most of the saline springs of Great Britain take their rise in the new red sandstone formation. Mr. Gairdner remarks, however, that those of Cheltenham rise in a stratum of blue clay abounding in iron pyrites, which repose on the inferior oolite limestone; a circumstance which, according to him, furnishes an explanation of the well-known fact, that these mineral waters are strongest when first opened, and gradually decrease in strength until it becomes necessary to sink new wells in order to obtain water of the requisite strength. The specific gravity of the water of four of the springs belonging to Thompson's Spa was observed to be diminished, and two to be increased, between 1817 and 1820, to such a degree as to excite the surprise of chemists. The number of springs at present is fourteen, each of which present some slight difference in the amount of the saline ingredients and their concomitants. The most important differences are owing to the presence of iron in some, occasionally accompanied with carbonic acid and sulphuretted hydrogen. Iodine in the proportion of about one grain to a gallon of the water exists in most of them, except the Pittville spring, in which however bromine is found in the proportion of one grain to six gallons of the water. Those in which no iron exists partake much of the nature of sea-water, and resemble it in effects when used internally; while those in which it is present are of a chalybeate nature, and, especially when the quantity of carbonic acid is considerable, can be borne by persons who cannot tolerate the simple saline waters, and can likewise be used for a much longer time without inducing debility. It is sometimes advisable to change from one kind to another, according to the state or progress of the patient, all which points will be regulated by physicians on the spot.

The persons most benefited by the Cheltenham waters are those who, after a long residence in hot climates, are affected with diseased liver; and also those who by indulgence in good living have weakened the stomach and intestines. The mucous accumulations which occur in the bowels of children subject to worms are best removed by a course of the pure saline waters, followed by the aërated chalybeate or the sulphureous chalybeate. Children subject to glandular enlargements derive much benefit from those waters which contain iodine along with iron.

CHEMICAL AFFINITY. This term is applied to denote the agent or power by which certain phenomena are produced when substances are brought into contact with each other. It is also used to signify the peculiar force or power, the presence of which in compound substances binds together or retains in combination the elementary bodies of which they are composed. Thus, when charcoal is ignited in contact with air, the light and heat produced are said to result from the exertion of chemical affinity between the charcoal and one of the constituents of the atmosphere,—namely, oxygen; whilst the elements of the carbonic acid formed in this combustion are also regarded as being retained in combination by virtue of the permanent action of the same power—chemical affinity. This power is sometimes denominated the *chemical force*.

Chemical affinity may be distinguished from all the other powers of matter, except cohesion, by acting only between bodies which are either absolutely in contact or at insensible distances from each other. Thus, whilst gravity exerts its influence between particles of matter placed at inconceivably great distances, and light, heat, and electricity are capable of manifesting their effects through probably equally immeasurable spaces, there is not the slightest effect produced by placing a globule of potassium at the smallest perceptible distance from a drop of water, although these bodies are capable of displaying an affinity of such intensity as to cause them to burst into flame when they are brought into actual contact.

From the force of cohesion, chemical affinity may also be distinguished by several marked peculiarities. Two pieces of glass ground perfectly flat and smooth, when placed upon each other and pressed together, cohere with such force as to require a weight of some scores of pounds to separate them; indeed, it is stated that, if the pressure be great and long continued, the two pieces become so firmly united as to render their subsequent separation at the precise line of junction nearly impossible. The force holding the pieces of glass together,—cohesion, causes however not the slightest alteration in the properties or appearance of the bodies between which it is thus exerted, and if the two pieces of glass were of different colours they could still be individually distinguished in the compound mass. But the exertion of the chemical force is attended with very different results: when iron is exposed to air and moisture, it is, by the exertion of chemical affinity, gradually converted into a red-brown powder, well known as iron-rust, in which none of the peculiar properties of the metal or of the atmospheric oxygen are distinguishable. No one ignorant of the fact could imagine the bright, hard, and heavy metal iron to be present in the dull, friable, and comparatively light rust; nay, even the most powerful microscope utterly fails to distinguish a particle of iron in the compound thus formed. Chemical affinity is therefore distinguished from cohesion by the complete change which it effects in the character and properties of the substances between which it is exerted. The force of cohesion may be overcome by mechanical power alone,—the hardest solids may by suitable mechanical means be reduced to impalpable powder; but the separation of bodies united by the chemical force can very rarely be effected by mechanical agency alone; no amount of grinding, fracture, or pulverisation can effect the slightest separation of the particles of iron and oxygen in the rust above mentioned.

The simplest cases of chemical affinity are those in which two elementary bodies unite into a binary compound, as when iron combines with oxygen to form oxide of iron. This is the result of what is termed *single affinity*, and this power may be exerted between two elementary or two compound bodies; and also, though it occurs more rarely, between an elementary and a compound substance. For example, sulphur and copper, both elementary bodies, readily unite when heated; sulphuric acid and oxide of copper, both compounds, combine with great readiness; but no combination of sulphur and oxide of copper, or of sulphuric acid and copper, is at present known. There is then a greater disposition to combination between two elements or two compounds, than between an element and a compound. The rule is, however, by no means without exception; for cyanogen, a compound body, combines with mercury, an elementary one, to form cyanuret of mercury.

It has been mentioned that, when bodies combine by chemical affinity, they undergo great change of properties. It might, however, be supposed that a compound would possess qualities intermediate between those of its constituents. This, however, is by no means the case; nor, even though we may be well acquainted with the properties of the elements, can we at all tell, *à priori*, what kind of a compound they will form. Sulphur is yellow, copper is red, but the sulphuret of copper, resulting from their union, is black. Again, sulphuric acid has great affinity for water, and when diluted turns vegetable blues red. Potash has also great affinity for water, and renders vegetable blues green. The acid and potash are also both extremely acrid, and they have great affinity for each other; but combine them by *single affinity*, and a salt, called sulphate of potash, is produced, which has very slight affinity for water, does not act upon any vegetable colours, and, instead of being acrid to the taste, like both its constituents, is merely bitter and saline. In this case of chemical affinity an almost total reversal of properties has occurred; but there are cases in which it is far from being so complete, and in which one or both of the ingredients still exert some of their original powers: thus, the sulphate of potash, above alluded to, is capable of combining with an additional quantity of sulphuric acid. This salt, which is called bisulphate of potash, resembles both its constituents in having affinity for water, as is shown by crystallising in combination with it, and by being readily soluble in it; and it resembles sulphuric acid in having a sour taste, and turning vegetable blues red.

We have stated a few examples of the changes produced in bodies by a combination effected by chemical affinity. The alterations, in many cases, are more striking and complete; the properties of the substance formed by the combination being altogether different from those of the bodies from which it has originated. Sulphuret of copper, as already noticed, differs in colour from both its elements, yet it resembles both in being solid; but there are numerous cases in which the form, colour, smell, taste, density, and other physical qualities, and the chemical properties of fusibility, volatility, solubility, and tendency to combination in the compound, bear no resemblance to its constituent parts.

Although, when speaking of the action which is induced by chemical affinity, chemists are frequently in the habit of stating merely that one substance has affinity for another, yet it is to be understood that the force with which bodies unite arises from mutual and equal affinity: thus, sulphuric acid and potash combine, not merely on account of the affinity of the acid for the alkali, but of the alkali

equally for the acid. Chemical affinity, then, is mutual and equal between those substances which combine by its power. Many different compounds may be formed by uniting one substance, an acid, for example, with various others, as with the alkalies, earths, and metallic oxides; these are called bases; and the force of affinity of any acid for any base differs in every instance. Now, this difference constitutes what has been termed *elective affinity*,—the existence of which is easily proved, and the results of its action are of the highest importance, both in a scientific point of view, and with regard to chemical agency as connected with the most common processes in the chemical arts and manufactures.

Nitric acid is capable of combining by *single affinity* with lime or with magnesia; and if some dilute nitric acid, containing 54 parts of real acid, be mixed with 28 parts of lime, the earth will be dissolved in the acid, and a neutral solution of nitrate of lime is obtained. A similar quantity of this acid forms a neutral solution of nitrate of magnesia by combining with 20 parts of that earth. Now, if we mix together 54 parts of nitric acid, 28 of lime, and 20 of magnesia, it might be supposed that the acid—which is of course incapable of dissolving the whole of both of the earths—would dissolve them in the proportions of 14 of lime and 10 of magnesia: it is found, however, that this is not the case, for the whole of the lime is dissolved and the magnesia entirely left.

It appears, then, a greater mutual affinity (an *elective affinity*) exists between nitric acid and lime, than between nitric acid and magnesia. There is another mode in which elective affinity acts, and in which it is employed in a vast number of chemical processes. It has been just stated that 54 parts of nitric acid combine with 20 of magnesia by single affinity. Now, if to the solution of nitrate of magnesia thus obtained we add 28 parts of lime, and boil the mixture, the lime separates the magnesia from the nitric acid; and being dissolved instead of it, we procure a solution of nitrate of lime, instead of nitrate of magnesia: this operation is termed *single decomposition*, and it is produced by single elective affinity. It is therefore evident, that this power may not only prevent one substance from combining with another when three are mixed, but supposing two to have been previously combined, it is capable of effecting a separation between them.

On the action of single elective affinity producing single decomposition, depends the process of preparing acetic acid from acetate of soda by means of sulphuric acid; and the production of ammoniacal gas by distilling a mixture of lime, sulphate of ammonia, and water.

To exhibit the degrees of elective affinity, tables were constructed by Geoffroy, a French chemist, about a century ago. In these the substance whose affinities are to be expressed is placed at the head of a column, and is separated from the rest by a horizontal line; beneath this line are arranged the bodies with which it is capable of uniting in the order of their respective forces of affinity; the substance which it attracts most strongly being placed nearest to it, and that for which it has the least affinity at the bottom of the column; thus, in the case of sulphuric acid, the affinities are exhibited in the following order :—

SULPHURIC ACID.

Baryta,
Strontia,
Potash,
Soda,
Lime,
Magnesia.

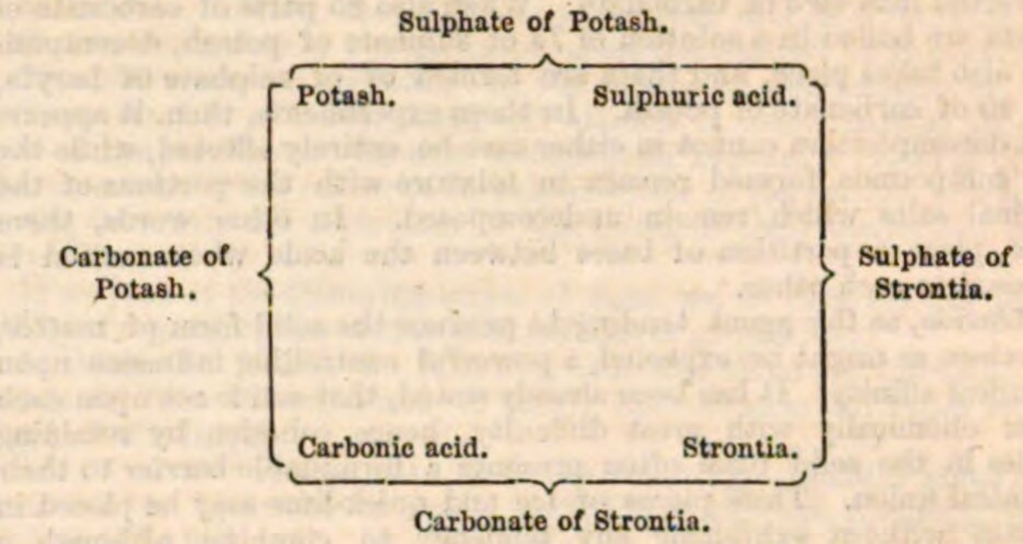
It would appear from this table, that baryta separates sulphuric acid from combination with all the substances placed below it, and that magnesia is separated from sulphuric acid by all that are above it. There are, however, many circumstances which interfere with the accuracy of tables thus constructed, and diminish their utility, since affinity is not an absolute force, but subject to anomalies and to modifications from various disturbing causes.

In the above, and many similar tables, the affinity of an acid for different bases is expressed; but on other occasions, the affinity of the same bases for different acids is required. In this case the alkali, earth, or metallic oxide, is placed at the head of the column, and the various acids are arranged according to their affinity for it.

There is yet another mode in which elective affinity is exerted. Certain compounds can scarcely be obtained at all, or with great difficulty, either by single affinity or single elective affinity, but are readily obtained by what is termed *double elective affinity*. There is a well-known mineral body called sulphate of strontia, which consists of sulphuric acid and the earthy base (or strictly speaking, metallic oxide) strontia, and they are combined by single affinity. Now potash has great affinity for the sulphuric acid of the sulphate of strontia; but if we mix them, no decomposition takes place, the potash being incapable, by single elective affinity, of detaching the sulphuric acid from the strontia. Again, carbonic acid and strontia have great affinity for each other, but if carbonic acid gas be passed through water in which powdered sulphate of strontia is diffused, it does not by single elective affinity separate the strontia from the sulphuric acid.

That decomposition, however, which single elective affinity cannot in this case perform, may be effected by double elective affinity, producing *double decomposition*. If, instead of acting upon the sulphate of

strontia with the carbonic acid and potash separately, we combine them and boil the powdered sulphate of strontia in a solution of the carbonate of potash thus formed, double elective affinity ensues, and two new compounds are formed—namely, sulphate of potash, which remains in solution, and carbonate of strontia, which, being insoluble in water, is precipitated in the state of a white powder. The double elective affinity which produces double decomposition will be illustrated by the annexed diagram.



Double elective affinity and decomposition are extensively employed in chemical operations; the preparation of various acids, such as the nitric and hydrochloric, and of a great number of saline compounds, depends upon the application of these modifications of chemical affinity. We shall now illustrate a position already stated, viz., that chemical affinity is not to be considered as an invariable power, but subject to causes which prevent, increase, or reverse its action; and it is on this account that tables of affinity express merely the order of decomposition, and not that of attraction under every circumstance. The causes now alluded to may be comprehended under *form* and *proportion*, and the modifying effects of cohesion, heat, electricity, and light.

With respect to *form*, it may be observed, that the solid state is unfavourable to the exertion of chemical affinity; and it was once supposed that two solid bodies could not act chemically upon each other. That this is not the case may be proved by adding lime to chloride of ammonium, for by their mutual action ammoniacal gas is plentifully evolved. Division is, however, in all cases favourable to chemical affinity: thus a mass of marble dissolves slowly in hydrochloric acid, but when reduced to powder the action is extremely rapid. The same effect is seen in the case of carbon in the three states of coke, charcoal, and tinder. Coke, the hardest and most compact of the three, can be ignited, that is, made to combine with atmospheric oxygen, only with difficulty, the lighter and more porous charcoal is much more easily ignited, whilst tinder readily takes fire from the smallest spark.

Minute division, then, so as to reduce the cohesion of a body, is in some cases necessary to the exertion of chemical affinity, and in all cases it increases the rapidity of its action.

Fluidity is always favourable to chemical action, and in most cases it is requisite that one body, at least, should be in that form.

Thus the tartaric acid and carbonate of soda contained in common effervescing powder do not act upon each other so long as the mixture remains in the solid state, but when the powder is thrown into water it dissolves, the affinity of tartaric acid for soda comes into play, and the carbonic acid is expelled.

The nascent state of bodies is one which is extremely favourable to the action of chemical affinity. Chlorine has affinity for silver, and the compound which they form, called chloride of silver, is white and insoluble in water; hydrogen has great affinity for chlorine, and they combine to form hydrochloric acid. If, however, hydrogen gas be passed into water holding chloride of silver in suspension, no change occurs, for the hydrogen has not, under these circumstances, the power of separating the chlorine from the silver.

If the hydrogen be evolved in the vessel which contains the suspended chloride of silver, it has then an opportunity of coming into contact with it in its *nascent state*, that is at the moment of its separation from combination, and before it has assumed the state of gas. Under these circumstances the hydrogen separates the chlorine from the silver, hydrochloric acid is formed, and metallic silver separated. The gases which constitute ammonia, namely, hydrogen and nitrogen, do not unite unless one of them, at least, is in the nascent state: thus if iron filings moistened with water are exposed to nitrogen gas confined over mercury, ammonia is produced, for the water is decomposed by the iron, its nascent hydrogen unites with the nitrogen to form ammonia, and its oxygen with the iron to form the oxide of that metal.

The nature of the compounds, arising from the chemical affinity and action of their elements, is greatly influenced by the *proportion* of the substances employed to produce them. When equal weights of sulphuric acid and alcohol are subjected to distillation, the product is sulphuric ether; double the quantity of acid, and oil of wine is obtained; use ten parts of acid to one of alcohol, and olefiant gas is formed by their mutual action. Again: if a mixture of two parts of nitre and one part of sulphuric acid be distilled, there are produced

nitric acid and sulphate of potash; but if a part of the sulphate of potash be dissolved in the nitric acid, nitrate of potash will be again formed, accompanied with bisulphate of potash.

There are several other cases which prove that the proportions of the substances which act chemically upon each other, greatly influence the nature and proportions of the new compounds formed: thus, when 100 parts of sulphate of baryta are boiled in a solution of 59 parts of carbonate of potash, 23 of the sulphate are decomposed and converted into 19·3 of carbonate. When also 85 parts of carbonate of baryta are boiled in a solution of 74 of sulphate of potash, decomposition also takes place, and there are formed 67 of sulphate of baryta, and 40 of carbonate of potash. In these experiments, then, it appears that decomposition cannot in either case be entirely effected, while the new compounds formed remain in mixture with the portions of the original salts which remain undecomposed. In other words, there takes place a partition of bases between the acids whose action is opposed to each other.

Cohesion, as the agent tending to produce the solid form of matter, exercises, as might be expected, a powerful controlling influence upon chemical affinity. It has been already stated, that solids act upon each other chemically with great difficulty, hence cohesion by retaining bodies in the solid form often presents a formidable barrier to their chemical union. Thus pieces of ice and quick-lime may be placed in contact without exhibiting any tendency to combine, although a violent action immediately ensues when an elevation of temperature causes the liquefaction of the ice. The most important and interesting effects of cohesion upon chemical affinity are, however, observed when the former force comes into play between substances in solution: thus, when nitrate of baryta is mixed with sulphate of potash, mutual decomposition of the two salts is effected, chiefly by the agency of cohesion, which solidifies and withdraws from solution a compound of the sulphuric acid, of the sulphate of potash, with the baryta of the nitrate of baryta. This controlling effect of cohesion is one of the most fertile sources of chemical change.

Heat, according to its degree and under various circumstances, produces very different effects on chemical affinity, and causes, increases, reverses, or prevents its action. If we mix oxygen and hydrogen gases, they will remain in a state of mixture for an indefinite period without combining; but if flame be applied to them they combine with explosion, and water is formed. When mercury is moderately heated in atmospheric air it is converted into peroxide, by combining with the oxygen of the air: heat the compound thus formed more strongly than was required for its production, and the affinity is destroyed; oxygen gas is given out, and the mercury returns to its metallic state. Mix solutions of chloride of calcium and carbonate of ammonia; double decomposition ensues; carbonate of lime and chloride of ammonium result. Evaporate the mixture to dryness, and heat the residue; the order of affinities is reversed, and chloride of calcium and carbonate of ammonia are reproduced: in this case, heat reverses the order of affinities. There is one instance, however, in which heat produces effects that are quite anomalous and irreducible to any idea of their dependence upon degree of temperature; it is this:—when the vapour of boiling water is passed over ignited iron, the water is decomposed; hydrogen, one of its elements, is evolved in the state of gas; and oxygen, the other, combines with the iron and converts it into oxide. Now if we ignite this oxide of iron and pass hydrogen gas over it, the oxide is decomposed, its oxygen combines with the hydrogen, and water is re-formed. No satisfactory explanation of these opposing results has hitherto been offered. These facts afford an illustration of the disturbing causes which very much limit the usefulness of tables of affinity. According to the first experiment, oxygen and iron combine in preference to oxygen and hydrogen, whereas it appears from the second that the affinity of oxygen for hydrogen exceeds that for iron. But it is evident that these statements are irreconcileable with each other; and as the temperature is in both cases the same, no variation of it can account for the incompatible results of the experiments.

Electricity possesses remarkable power over chemical affinity: if the electric spark be passed through a mixture of oxygen and hydrogen gases, it causes them to combine, and water is formed by their union. It is probable that this and some similar effects are produced by the heat which accompanies the electrical spark.

The action of electricity is much more remarkable in causing decomposition than combination, and especially that form of it which is termed voltaic electricity, or galvanism. The first substance decomposed by it was water. When two platinum wires are connected with the poles of a voltaic trough, and their unconnected ends are immersed in water, hydrogen gas is evolved at the negative, and oxygen gas at the positive wire. Many other compound bodies have been similarly decomposed; their elements separate at the opposite poles, and the same body always appears at the same pole: thus, in all decompositions, oxygen, chlorine, and the acids go over to the positive surface, while hydrogen, the metals, and the alkalies are found at the negative surface.

In common electrical attraction, the bodies attract each other in consequence of their opposite electrical states; and in the same manner, in the electro-chemical theory proposed by Sir H. Davy, it is supposed that acids and other substances which are attracted in

electrical decompositions to the positive pole, are negatively electrical at the moment of their separation from combination; and on the contrary, the alkalies, which are found at the negative extremity, are positively electrical.

It has, however, by no means been proved that chemical affinity is identical with electrical attraction; and we must yet consider the former as a peculiar species of attraction, subject indeed to the control of electrical agency, which is capable, not merely of decomposing compounds, but of suspending chemical action and reversing the order of affinities.

If sulphate of soda be dissolved in a blue vegetable infusion and subjected to voltaic electricity in a glass tube, it is soon found that the fluid at the positive pole becomes red, indicating the presence of an acid, while at the negative it is green, showing the action of an alkali. In this case the sulphate of soda is not only decomposed, but its constituents, while under electrical influence, appear to be incapable of recombining; for, by reversing the position of the tube, or the places of the wires, the fluid which was red will become green, and the green red; thus proving that, while under electrical influence, chemical affinity is suspended, for the acid and the alkali must have passed through the same solution without combining.

That affinity may be controlled by altering the electrical state of a body, is also proved by Sir H. Davy's very curious experiments on copper-sheathing, which, though they failed from unforeseen causes, are worthy of his genius. It appeared to Sir H. Davy that the copper was oxidised by the atmospheric air in the sea-water, and that then it combined with hydrochloric acid derived from chloride of magnesium, and formed with it subchloride of copper, and hence ensued the destruction of the metal. Now, as metals combine with acids only when oxidised, it occurred to Sir H. Davy, that if he could render the copper negative, which is the electrical state of the oxygen, they would not combine. This he effected by bringing the copper into contact with zinc or iron; these being rendered positive, the copper became negative, scarcely combined at all with oxygen, and was so little acted upon by the chloride of magnesium in sea-water, that when protected by only 1-1000th part of iron, oxidisement and conversion into subchloride were, to a certain extent, prevented.

The following will also serve as an example of the reversal of chemical affinity by electricity: Immerse a piece of copper in a solution of nitrate of silver; the copper is dissolved, and the silver precipitated; if we reverse the experiment, and put a piece of silver into a solution of nitrate of copper, no change is effected; if, however, the silver while immersed be touched by a piece of platinum, a voltaic circuit is formed, the order of affinity is reversed, the copper is precipitated, and the silver is dissolved.

Light is capable of controlling chemical affinity, both with respect to decomposition and combination. If a mixture of hydrogen and chlorine gases be exposed to the sun's rays, they combine with explosion, and form hydrochloric acid; this effect does not appear to be produced by the heat which accompanies the light, for a considerably higher temperature is not capable of producing the combination. With respect to the decomposing agency of light, it is well known that if pale nitric acid be subjected to it, it suffers decomposition to a certain extent, oxygen gas being evolved; it is also found that some metallic oxides which retain the oxygen with but slight force of affinity, evolve it and are reduced to the metallic state by the agency of light. Several of the beautiful processes of photography depend upon this effect of light in modifying chemical affinity.

In concluding the subject of chemical affinity, it is to be observed, that substances often combine in more than one proportion of each, and the quantities are governed by certain laws which have been considered under ATOMIC THEORY.

CHEMICAL ANALYSIS. Those chemical operations which have for their object the discovery or determination of the different kinds of matter of which any compound substance consists, are termed *analytical* operations, and this department of chemical science is called chemical analysis.

Substances are subjected to chemical analysis for the purpose of determining (1) what constituents they contain, and (2) the amount of such constituents. The processes adopted for the first of these objects constitute *qualitative*—those for the second, *quantitative analysis*. Both qualitative and quantitative analysis may be only partial; that is, in qualitative analysis it may only be required to detect one or more constituents in a compound substance, or, in quantitative analysis, the estimation of the amount of one or more constituents may be desired. An example of the first is the detection of poisons in animal substances; of the second, the determination of the commercial value of a manure. It follows that very different methods may have to be employed in the partial examination of a substance either qualitatively or quantitatively, according to the particular constituents which have to be sought for or estimated. The examination of a substance, on the other hand, may be total, either in respect to the nature or amount of the constituents it contains; that is, we may have to determine either qualitatively or quantitatively, the whole of the substances present.

Further, in both divisions of analysis, different methods have to be employed, according as it is required to detect or estimate the proximate, or ultimate (elementary) constituents. For instance, in the

examination of a mineral, we may be satisfied with the detection of iron, or with the estimation of its amount; or, on the contrary, it may be required to be known in what stage or stages of oxidation the iron exists, or how much of the different oxides are contained in the mineral.

It is, however, clear that, whatever be the kind of information sought regarding the nature of a substance, the processes to be adopted will have greater or less similarity according as the substances examined are more or less alike; and it follows hence that as substances may be grouped together in classes, whose members resemble one another chemically; so the processes of analysis applied to the members of the same class bear also a likeness to one another.

Thus those substances which were (historically) first derived from the animal and vegetable kingdoms, and the artificially prepared bodies resembling them in composition—the so-called organic bodies—contain invariably carbon, generally hydrogen, frequently oxygen and metals, sometimes nitrogen, and occasionally sulphur, chlorine, phosphorus, &c. In many instances, such bodies may have to be divided into their proximate constituents: in such cases special knowledge must be had of the nature and behaviour of these constituents. But a question more frequently to be solved with regard to organic bodies, is the determination, qualitatively or quantitatively, of their ultimate constituents or elements. The importance of this species of analysis, and the similarity of the methods employed upon the different organic substances, renders a special article necessary for their consideration. [Organic Analysis.]

Again, the physical state in which a body is presented for analysis—whether as a solid, a liquid, or a gas, renders corresponding variations of method and apparatus necessary. This is especially the case with gases and vapours, and hence a separate article will be devoted to this branch of analysis. [Gasometric Analysis.]

Inasmuch as most inorganic chemical compounds consist of one or more bases, acids or salts [Acid; Base; Salt], qualitative and quantitative inorganic analysis consists mainly of the detection, separation, and estimation, of the various bases and acids (for the detection and separation of these of course includes those of the salts resulting from their union). Again, as most bases are metal, or contain a metal, the detection, separation, and estimation of the metals is of the first importance in qualitative and quantitative analysis.

It is proposed, in the limits of the present article, to give a general outline of the chemical analysis of inorganic liquids and solids. To do this it will be necessary to describe, in qualitative analysis—1st, how the bases are separated into groups; 2nd, how the members of the groups are separated from one another; 3rd, the detection of the most important acids. A general sketch will then be given of the principles and practice of quantitative analysis.

Qualitative analysis. The chief means used in separating the metallic bases from one another is founded upon the difference of solubility of their analogous compounds in the same medium.

Thus if the metals be made to combine with oxygen, the so-formed oxides are found to be soluble in water in the following different degrees:—

	Very Soluble.	Less Soluble.	Difficultly Soluble.	Insoluble.
Oxides of	K, Na, NH_4*	Ba, Sr, Ca	Mg	Al, Cr, Fe, Mn, Zn, Ni, Co, Sn, Pt, Au, Hg, Pb, Ag, Bi, Cd, Cu.

Again, on examining the chlorides of the metals, we find that—

	Very Soluble.	Difficultly Soluble.	Insoluble.
Chlorides of	K, Na, NH_4, Ba, Sr, Ca, Mg, Al, Cr, Fe, Mn, Zn, Ni, Co, Pt, Au, Hg, (HgCl), Cd, Cu	Pb	Hg, (Hg_2Cl), Ag.

The compounds formed by the union of other elements, or groups of elements (acids), with the metals, show again a different order of solubility; and it is by this difference in solubility in different media, of the analogous compounds of the metals, that their separation from each other is chiefly effected.

Thus, if a solution contains silver and copper, and by any means both the metals are converted into chlorides, it is clear that, the chloride of silver being an insoluble substance in water, may be separated from the soluble chloride of copper; that is, the silver may be separated from the copper. When one metal has been thus converted into an insoluble compound in a solution, it is said to be precipitated or thrown out of solution in a solid form; and it may generally be separated from the soluble compounds of other metals present by filtration through unsized paper.

Very frequently analogous compounds of different metals, which are equally soluble or insoluble in water, show different degrees of solubility in other media. Often an acid or alkaline medium affects differently in this respect analogous compounds of bodies which are equally soluble or insoluble in water: and this is in most cases due to the difference which such compounds possess in their liability to be

* The salts of the quasi-metal ammonium (NH_4) are so analogous to those of the metals proper, and ammonium is of so frequent occurrence in nature, that it is included among the metals.

decomposed by such media: sometimes, however, to a true difference in the solvent power of the medium. An example of the difference of solubility in another medium of analogous compounds (which are equally insoluble in water), is furnished by the sulphides of zinc and of cadmium. The former is dissolved in (and decomposed by) hydrochloric acid, the latter is unchanged. Again, the sulphides of tin and copper are insoluble both in water and hydrochloric acid. But the former is soluble in caustic potash (and combines with it); the latter is insoluble. Further, the chlorides of barium and of strontium are both soluble in water; but the latter alone is dissolved by alcohol.

The difference of solubility of the analogous compounds of the different metals in water, acids, and alkalies is most marked in the case of the sulphides. On this account, and because a metal is often characterised by the colour of its sulphide, one of the earliest processes in the detection and separation of the metals is their conversion into sulphides.

If we look at the following series of facts, we at once see the possibility of separating the metals into families or groups:—

I. Of all the metals, the following chlorides alone are insoluble, or nearly so, in cold water, and in dilute hydrochloric and other acids, AgCl, PbCl, Hg_2Cl. . . . . A.

II. Of all the metals not in A, the following sulphides alone are insoluble in hydrochloric acid, HgS, BiS, CdS, CuS, $AsS_3(S_5)$, $SbS_3(S_5)$, $SnS(S_2)PtS_2AuS_3$. . . . . B.

III. Of all the sulphides in B, the following alone are soluble in alkalies and alkaline sulphides, $AsS_3(S_5)$, $SbS_3(S_5)$, $SnS(S_2)$, PtS_2, AuS_3. . . . . C.

IV. Of all the metals not in A and B, the following alone are precipitated by excess of ammonia (as oxides), even when soluble salts of ammonia are present, Fe_2O_3, Cr_2O_3, Al_2O_3. . . . . D.

V. Of all the metals not in A, B, and D, the following alone form sulphides which are insoluble in water, MnS, ZnS, NiS, CoS. . E.

VI. Of all the metals not in A, B, D, and E, the following alone form carbonates which are insoluble in water, even in the presence of soluble salts of ammonia, $BaO\,CO_2$, $SrO\,CO_2$, $CaO\,CO_2$ . . F.

VII. Of all the metals not in A, B, D, E, F, the following alone forms an insoluble arseniate and phosphate, Mg . . . . G.

VIII. The remaining metals, whose chlorides, sulphides, oxides, carbonates, phosphates, and arseniates are soluble, are the alkaline metals, K, Na, NH_4 . . . . . H.

According to a part of Berthollet's doctrine of the conditioning of chemical change, the entire union of one of two bodies in a solution with another is dependent upon the insolubility of the resulting compound. So that by bringing two compounds together which by reciprocal interchange of their constituents may give rise to an insoluble new body, that body will be formed.

A. If, therefore, we have a solution containing all the metals, and add to it an excess of hydrochloric acid, those metals whose chlorides are insoluble in water and hydrochloric and other acids, will be precipitated as chlorides, and, as such, may be separated by filtration from all the other metals.

B. and C. On passing sulphydric acid through the acid, filtrate from the precipitated chlorides A, until it is perfectly saturated with the gas; all the metals of the group B, and none others, will be precipitated as insoluble sulphides, and may be separated from all the remaining non-precipitated metals by filtration.

D. The filtrate from B and C contains all the remaining metals, and is saturated with sulphydric acid, which, though it has not precipitated the iron, has reduced it to the state of protoxide. On boiling this filtrate to expel the sulphydric acid, then boiling with nitric acid to peroxidise the iron, and adding chloride of ammonium and ammonia in excess, the metals D are precipitated as oxides, and may be separated from the remaining metals by filtration. If the hydrosulphuric acid be not expelled, an alkaline sulphide (sulphide of ammonium), would be formed on the addition of ammonia, which would precipitate the metals E. If the iron be not peroxidised, a portion of the protoxide would be dissolved by the ammoniacal salts formed on the addition of ammonia, and would appear in the filtrate. If a large quantity of chloride of ammonium be not added, in addition to the salts of ammonia formed, the manganese will not remain entirely non-precipitated.

E. The oxides D having been separated by filtration, sulphide of ammonium added to the filtrate from D precipitates the metals E as sulphides.

F. On boiling the filtrate from E with an excess of carbonate of ammonia, the metals F are precipitated as carbonates. Magnesia is not precipitated on account of the soluble ammoniacal salts present.

G. The filtrate from the alkaline carbonates F, on being treated with arseniate of ammonia, forms a precipitate of arseniate of magnesia and ammonia. G.

G. The filtrate from G on evaporation to dryness and ignition until all the arsenical and ammoniacal salts introduced are volatilised or decomposed, contains the alkalies H.

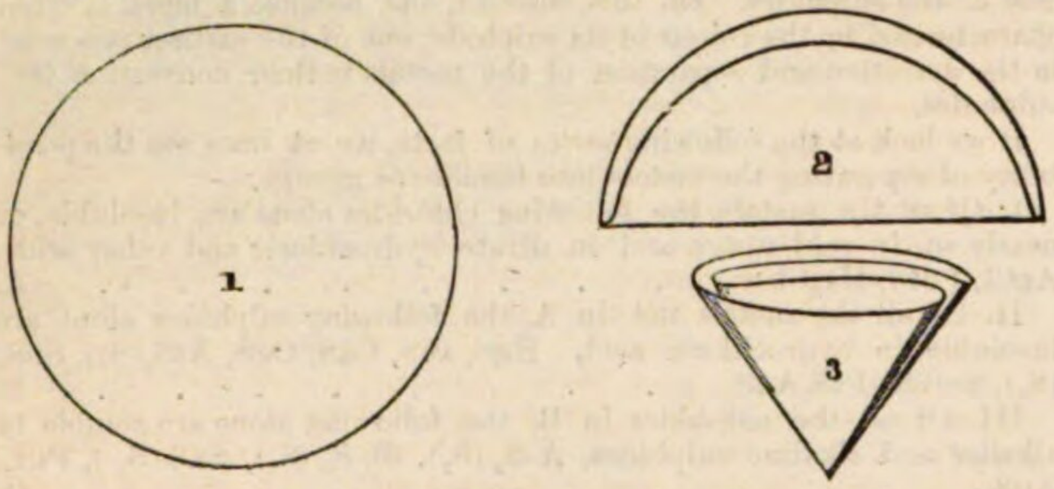
Since ammonia and its salts have been employed in the separation of the groups, ammonia itself must be tested for in the original solution, or in the filtrate from A.

It is self-evident that in every case where a reagent is used to separate a group, that reagent must be used in excess, that is, in more than sufficient quantity to effect the separation (precipitation or solution),

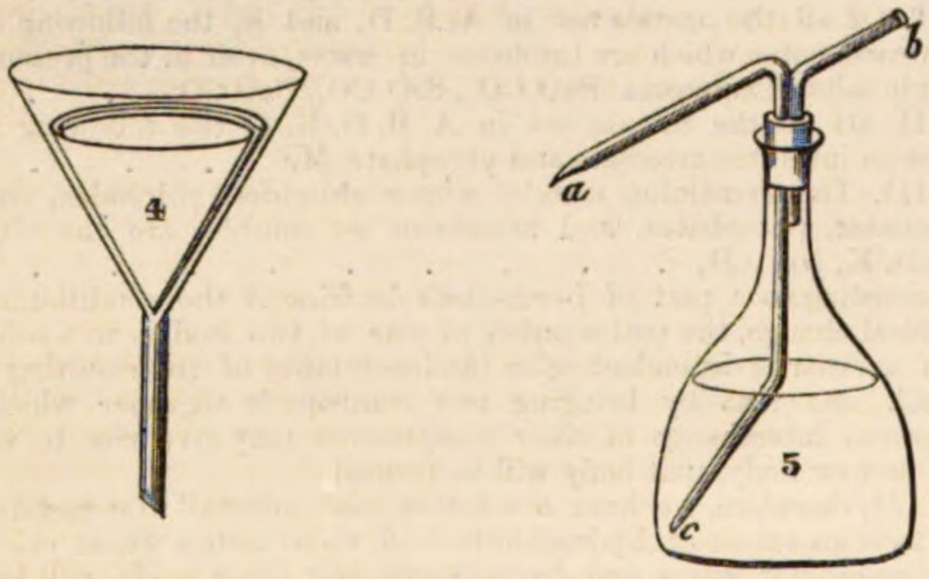
in order to ensure its completeness. Hence, as a general rule, when, for instance, a precipitation has been effected and the insoluble compound separated by filtration, the filtrate should be treated with some more of the same reagent which has been employed in the precipitation, and if the latter has been perfect, no further precipitation will be thereby produced.

It is also clear that when a precipitate has been formed in a solution and separated from the non-precipitated constituents by filtration, the precipitate is still moistened with the solution of the non-precipitated portions, and must be therefore cleansed from them by washing with water before further examination.

Figs. 1, 2, 3, show the successive foldings by which a filter is formed



from a round piece of unsized paper; 4 shows how the folds are opened so as to form a conical sack, having three folds of paper on one side and one on the other, and how it is placed in a glass funnel. Fig. 5, the washing bottle, is a narrow-necked glass flask, through



whose air-tight cork two tubes, open at both ends, pass; the one, A C, having its internal end beneath the water, the other, B, just passing through the cork. Air forced into B from the mouth presses the water into C, and projects it from A, where the tube is narrowed to a fine orifice.

The various substances added in order to separate the above groups of metals from one another, and each of which consequently behaves in the same manner to the members of the group which it separates, are called the *general reagents* of those groups. Thus carbonate of ammonia is the general reagent for the alkaline earths, barium, strontium, and calcium.

Space will not admit of a more detailed description of the separation of the various groups from one another, but from the following summary an idea may be formed of the process in each group.

A. Of the chlorides—chloride of lead (PbCl), chloride of silver (AgCl), and subchloride of mercury (Hg_2Cl), the chloride of lead alone is soluble in boiling water: of the two—chloride of silver and subchloride of mercury, chloride of silver alone is soluble in ammonia, subchloride of mercury being blackened but not dissolved by it.

B. Of the sulphide of mercury (HgS), bismuth (BiS), cadmium (Cd S), and copper (CuS), the sulphide of mercury alone is insoluble in strong nitric acid. From the nitrates of bismuth, cadmium, and copper, the bismuth alone remains permanently precipitated (as an oxide) on the addition of an excess of ammonia. From the ammoniacal solutions of cadmium and copper, the cadmium alone is precipitated (as a carbonate) by carbonate of ammonia.

C. The sulphides of arsenic, antimony, tin, gold, and platinum, dissolved in sulphide of ammonium are all precipitated as insoluble sulphides on the addition of hydrochloric acid; of these sulphides that of arsenic alone is soluble in carbonate of ammonia. Of the remaining sulphides, those of antimony and tin are converted into oxides (SbO_3, SnO_2) on ignition with nitrate of ammonia, while the sulphides of gold and platinum are reduced to the metallic state. Oxide of antimony is soluble in tartaric acid, while neither binoxide of tin nor metallic gold or platinum are dissolved by it. But gold and platinum are both dissolved by nitro-hydrochloric acid, in which binoxide of tin is insoluble.

D. The sesquioxides of iron, chromium, and aluminium, are soluble in hydrochloric acid. All these three metals are precipitated by cold caustic potash (as oxides) from the so-formed chlorides, the oxide of iron alone is insoluble in excess. Boiling caustic potash precipitates the oxide of chromium, but not the alumina.

E. The sulphides of zinc, nickel, cobalt, and manganese, are dissolved as chlorides by nitro-hydrochloric acid. From this solution carbonate of ammonia precipitates them all; but when added in excess, dissolves them all excepting manganese. Caustic potash precipitates oxides of nickel, cobalt, and zinc, and in excess only dissolves the oxide of zinc. Hydrochloric acid dissolves the oxides of nickel and cobalt; cyanide of potassium precipitates and dissolves in excess both nickel and cobalt from the acid solution of their chlorides. An acid added in excess to the cyanide of potassium solution, only precipitates the nickel as cyanide.

F. The carbonates of barium, strontium, and calcium are soluble in hydrochloric acid, the corresponding chlorides being formed. In a neutral or ammoniacal solution of these chlorides, chromate of potash precipitates the barium alone. Of the strontium and calcium, sulphate of potash precipitates the strontium alone, from dilute solutions.

G. Requires no separation.

H. It will be well to describe more fully, by way of example, the separation of the members of one group. For this purpose we will take that of the alkaline metals, potassium, sodium, and ammonium.

Ammonium is first tested for; this is done by adding caustic potash, soda, or lime to a portion of the solution, and heating. With whatever acid the ammonium is combined, the latter is liberated by the free base added, and is detected in the form of ammoniacal gas by its peculiar smell, by its alkaline reaction in turning reddened litmus blue, and by its fuming when a rod moistened with hydrochloric acid, of sufficient strength to diffuse sensibly in the air, is held in its presence. If no ammonia is found in this manner, the original solution is tested for potash. To a portion of it tartaric acid is added, and the sides of the vessel vigorously rubbed with a glass rod. A white crystalline precipitate of the tartrate of potash, whose formation is much accelerated by the agitation, shows the presence of potash. To a fresh portion bichloride of platinum ($PtCl_2$) is added, the solution is gently evaporated to dryness, and a mixture of equal parts of alcohol and ether is added; a heavy yellow crystalline insoluble residue shows the presence of potash. A perfectly clean platinum wire is dipped in a portion of the original solution (previously concentrated by evaporation), and held in the outer flame of the blowpipe. If on looking at it with the naked eye the flame appears yellow, this shows the presence of soda; if purple, it is evidence of potash. If the flame be yellow, potash may be present, because the yellow colouring power of the soda is much greater than the purple colouring power of the potash. If both are present, the purple colour due to the potash may be seen by viewing the flame through a piece of blue glass (cobalt glass), which intercepts the yellow light produced by the soda, and allows the purple of the potash to be recognised.

If ammonia was found in the first instance, it must be got rid of before testing for potash; because, like potash, it forms insoluble compounds with tartaric acid and with bichloride of platinum. This is done by evaporating the original solution to dryness and igniting it. The non-volatile residue is then dissolved in water, and examined as above for potash and soda.

After the metals have been separated into groups by the general reagents, and the members of each group separated from one another according to the preceding outline, the presence of the different metals found should be confirmed by the application of as many characteristic reactions as possible, that is, by applying special reagents to the solution which has been submitted to analysis; for when a substance shows a characteristic behaviour towards any reagent, the like of which is not shared by any other substance, the reagent is called special with regard to the substance. It follows that when only one or few substances are present or have to be tested for, the application of certain appropriate special reagents is often sufficient to indicate their presence or absence, and saves the time and trouble of the systematic separation above sketched, in which the whole of the metallic bases are supposed to be present.

The following are some characteristic reactions of the metallic bases, which reactions are not included in the above scheme:—

Copper is precipitated from an acid solution in the metallic state upon metallic iron. It is precipitated as a green carbonate by the carbonate of a fixed alkali; as a greenish blue hydrated oxide by a caustic fixed alkali in the cold; as a black oxide when heat is employed. It forms a mahogany-coloured precipitate with ferrocyanide of potassium.

Cadmium is a volatile easily oxidisable metal, whose sulphide is yellow.

Bismuth is precipitated from its acid solutions by water, basic insoluble salts being formed.

Mercury is a volatile metal; all its compounds are reduced to the metallic state either by heat alone, or in the presence of alkalies or alkaline carbonates. The salts of its peroxide form a red chromate, a red iodide, and a yellow oxide. It is precipitated in the metallic state by metallic copper.

Lead is precipitated as a white hydrated oxide by a fixed alkali. It forms white insoluble carbonates and sulphates. Its chromate and iodide are yellow and insoluble; most of its compounds are reduced to

the metallic state by heat in the presence of carbon, or from solutions by metallic zinc.

Silver is reduced from all its compounds at a red heat by alkaline carbonates.

Gold forms a purple precipitate with stanni-stannous chloride.

Platinum in acid solutions forms a yellow precipitate with soluble salts of ammonia and potash.

Tin, see *Gold*. Tin is reduced from most of its compounds by red-hot charcoal.

Antimony } The soluble compounds are decomposed by nascent
Arsenic } hydrogen, and the reduced metal forms with it antimonuretted and arsenuretted hydrogen, which are inflammable gases. Arsenuretted hydrogen reduces salts of silver. Metallic arsenic in a fine state of division is soluble in chloride of lime. Arsenious acid forms a yellow precipitate in ammonio-nitrate of silver, and a green one in ammonio-sulphate of copper. It is precipitated as a metal by metallic copper. The sulphide of antimony is converted into a volatile chloride by dry hydrochloric acid.

Aluminium. The oxide of aluminium, when heated with a salt of cobalt, becomes of a bright blue colour.

Chromium. The teroxide of chromium, or chromic acid, forms characteristically coloured salts (chromates), with various metallic bases. The sesquioxide and its salts are converted into chromate of potash by fusion with nitrate of potash.

Iron. The sesqui-salts of iron give a blood red colour with sulphocyanide of potassium, and a blue precipitate with ferrocyanide of potassium. The proto-salts are turned brown with nitric acid, and give a blue precipitate with ferricyanide of potassium.

Manganese. The sulphide of manganese is flesh-coloured. All compounds of manganese are converted into the bluish-green manganate of soda, on fusion with a mixture of carbonate of soda and nitrate of potash.

Cobalt imparts an intense blue colour to a bead of borax in the blowpipe flame.

Nickel. The oxide of this metal dissolves in ammonia with a blue colour.

Zinc is reduced to the metallic state by red-hot charcoal. The metal is volatile and easily oxidisable; its sulphide is white. Its oxide is yellow whilst hot, but white when cold.

Magnesia, when heated with nitrate of cobalt in the blowpipe flame, becomes flesh-coloured.

Lime forms an oxalate, insoluble in alkaline solutions and in acetic acid. It gives a red colour to the blowpipe flame.

Strontia. Its chloride imparts a crimson colour to the flame of alcohol.

Baryta forms a sulphate insoluble in water, alkalies, and acids.

For the special blowpipe reactions of the metallic bases, see BLOWPIPE.

The method of qualitative analysis thus briefly sketched, will be better understood by supposing we have to examine a solution containing a member of each group, under the supposition that we are, at the commencement, ignorant as to what it contains.

Let the solution contain,—

K, Sr, Mg, Al, Mn, Sn, Ag, HgO, Bi.

A portion of the solution is heated with caustic potash, no ammonia is evolved, therefore ammonia is absent.

To the remainder an excess of hydrochloric acid is added, a white precipitate (A) is formed.

The filtrate from A is saturated with hydrosulphic acid, a brown-black precipitate (B) is formed.

The filtrate from B is boiled alone, and then with nitric acid, chloride of ammonium is added, and then ammonia. A white precipitate (C) is formed.

To the filtrate from C, sulphide of ammonium is added, a flesh-coloured precipitate (D) is formed.

The filtrate from D is boiled with carbonate of ammonia, a white precipitate (E) is formed.

To a portion of the filtrate from E phosphate of soda is added, a white precipitate is formed. To the remainder arseniate of ammonia is added, a white precipitate (F) is formed.

The filtrate from F is evaporated to dryness, ignited and dissolved in water, giving solution G.

The separation of the metals into the groups has, therefore, been effected; the separation of the different members of the groups now follows.

The precipitate A is washed with boiling water on the filter. Sulphuric acid gives no precipitate in the filtrate, therefore *lead* is absent. Ammonia added to A does not blacken it, therefore *suboxide of mercury* is absent, but dissolves it, therefore *silver* is present. (Confirmatory: hydrochloric added to the ammoniacal solution, reprecipitates the silver as chloride; this is reduced to the metallic state on charcoal; dissolved in nitric acid, neutralised with ammonia, and the characteristic chromate and iodide of silver found on the addition of soluble chromates and iodides.)

The precipitate B is digested with sulphide of ammonium, it is filtered and hydrochloric acid added to the filtrate throws down a brown precipitate (G). The part of B insoluble in sulphide of ammonium is digested with nitric acid; a black residue remains, showing the presence of protoxide of *mercury*. (Confirmatory: the black insoluble mass is dried, mixed with carbonate of soda, and heated in a dry tube; metallic mercury volatilises and condenses on the cold part of the tube.) The filtrate from the sulphide of mercury is treated with an excess of ammonia, a white precipitate is formed, showing the presence of *bismuth*. (Confirmatory: the precipitate is separated by filtration, dissolved in nitric acid, and dropped into water, a white precipitate is formed. On adding carbonate of ammonia to the filtrate from the bismuth, no precipitate is formed, therefore *cadmium* is absent, on boiling the same solution with caustic potash no precipitate is formed, therefore *copper* is absent.)

The precipitate got by adding hydrochloric acid to the portion of B dissolved in sulphide of ammonium is digested with carbonate of ammonia and filtered, hydrochloric acid produces no precipitate in the filtrate, therefore *arsenic* is absent. That which has not been dissolved in carbonate of ammonia, is heated to redness with nitrate of ammonia, then digested with tartaric acid and filtered: hydrosulphuric acid throws down no sulphide from the filtrate, therefore *antimony* is absent. That which has not been dissolved in tartaric acid, is boiled in nitro-hydrochloric acid and filtered. Neither chloride of ammonium, nor protochloride of tin affect the filtrate, therefore *platinum* and *gold* are absent. That which has not been dissolved in nitro-hydrochloric acid is fused on charcoal with carbonate of soda: on scraping the fused mass into a mortar and washing with water, a malleable metallic globule is found, which shows the presence of *tin*. (Confirmatory: the globule is boiled with hydrochloric acid; on adding chloride of gold a purple colour is formed.)

The precipitate C is dissolved in hydrochloric acid; cold caustic potash produces a precipitate which dissolves in excess, therefore *iron* is absent: on boiling the caustic potash solution, no precipitate is formed, therefore *chromium* is absent; on adding an excess of hydrochloric acid and then an excess of ammonia, a white precipitate is formed, therefore *aluminium* is present. (Confirmatory: the precipitate is collected on a filter, dried and heated before the blowpipe with a solution of cobalt; a blue colour is produced.)

The precipitate D is dissolved in nitro-hydrochloric acid, and then boiled with an excess of carbonate of ammonia, a white precipitate is formed, therefore *manganese* is present. (Confirmatory: a part of the so-formed carbonate of manganese is fused with nitrate of potash and carbonate of soda, a bluish-green mass is obtained of manganate of soda; another portion of the manganese precipitate is fused in the outer blowpipe flame with borax, an amethyst bead is formed.) The filtrate from the manganese is boiled with an excess of caustic potash, no precipitate is formed, therefore *nickel* and *cobalt* are absent: sulphide of ammonium added to the caustic potash solution gives no precipitate, therefore *zinc* is absent.

The precipitate E is dissolved in hydrochloric acid, made alkaline by ammonia, and treated with chromate of potash, no precipitate is formed, therefore *barium* is absent. Sulphate of potash is added, and the liquid allowed to stand for some hours; a precipitate is formed, showing the presence of *strontium*. The filtrate from the strontium precipitate is made alkaline with ammonia, and then treated with oxalate of ammonia: no precipitate is formed, therefore *lime* is absent.

The precipitate F requires no examination, its formation proves the presence of *magnesium*.

The filtrate from F is evaporated to dryness, and ignited to expel the ammoniacal and arsenical salts; when the residue is dissolved in a little water, it gives a precipitate with tartaric acid and also with bichloride of platinum, therefore *potassium* is present. (Confirmatory: a wire dipped into the solution and held in the flame turns it violet, which shows also the absence of sodium.)

When the constituents of a body are quite unknown, a preliminary examination of it in the dry way often saves time by giving some clue to the bodies which are present. Thus the easy fusibility of a substance when heated on charcoal, generally points to the presence of the fixed alkalies. If it be heated in a narrow tube closed at one end, with carbonate of soda, ammonia and mercury, if present, are volatilised. If cyanide of potassium is added arsenic is volatilised, and so on.

If the body to be analysed is in the solid form it is examined as follows: It is boiled with water; if it dissolves completely, the method given above is at once applied. If it is only partly soluble in water, the insoluble part is boiled with hydrochloric acid and filtered; if anything remains insoluble in hydrochloric acid, it is treated with nitric acid, and should this leave anything undissolved, the residue is boiled with nitro-hydrochloric acid. The four extracts so got from the same quantity of the substance by these reagents are then mixed, and if any precipitation ensues, it is examined for the metals in A. Any substance which resists the action of all these reagents when successively used, does so in consequence of its containing some acid or non-metallic element. The method of analysing such bodies is best considered after the description of the behaviour of the acids.

Detection of acids. Just as a large number of the bases are chiefly detected by the peculiarity of their behaviour towards certain acids or salts containing them, so acids are in general detected by the peculiarity of their behaviour towards certain bases or salts containing the latter. Hence it frequently happens that an acid and a base are

mutually special reagents. And just as most of the chemical characters of a base are exhibited in its soluble salts, so most of those of the acids appear in their soluble compounds (for the so-called free acids are hydrogen salts). But in regard to their physical properties, this is not the case; for many acids when in such combination with hydrogen alone, that is, as free acids, are very much more volatile than when in union with metallic bases.

It is almost self-evident that all those acids which in the free state (under the ordinary conditions of pressure and temperature) are gaseous, are also volatile. When such an acid is by any means expelled from combination (from its base) more or less of it will be volatilised according as the free acid is less or more soluble in the liquid in which it is liberated; and this solubility, as with other gases, depends upon the nature of the acid, upon the nature of the liquid in which it is freed (principally in regard to the amount of solid matter it holds in solution), and upon the temperature to which the freed acid is subjected (leaving out of account the pressure upon it). According to their solubility in most liquids, and therefore, *ceteris paribus*, their degree of volatility, volatile acids may be divided into five tolerably well defined groups.

I. Most volatile, and therefore most easily driven off from solution when in the free state: Carbonic acid (CO_2), hydrosulphuric acid (HS), sulphurous acid (SO_2).

II. More soluble, therefore less volatile; requiring a higher temperature, or more concentrated solution for expulsion: Hydrocyanic acid (HCy), hydriodic acid (HI), hydrobromic acid (HBr), hydrochloric acid (HCl), nitric acid ($HONO_5$), hydrofluoric acid (HFl).

III. Much more difficultly volatile: Sulphuric acid ($HOSO_3$).

IV. Further, there are the non-volatile: Boracic acid (BoO_3), phosphoric acid (PO_5), silicic acid (SiO_3).

V. Those which are decomposed by heat, Chloric acid (ClO_5), Oxalic acid (HOC_2O_3).

As a general rule, the less soluble and more volatile an acid is, the more readily is it driven from its base by a more soluble or less volatile acid. Hence sulphides, sulphites, and carbonates, are generally decomposed, even at low temperatures, by almost any other acid such as one of the second group. These again are expelled from their salts by sulphuric acid, when in concentrated solution, or when heat is applied. The latter is expelled and volatilised at a strong heat, by one of the third group.

Hence the gases which are given off on adding hydrochloric acid to a dilute solution of a substance are to be examined for group I. Those which are expelled from a strong solution, or on heating (between 100°–305° Fahr.) with sulphuric acid (for, as before stated, concentration has here the same effect as heat), are to be examined for II. For the less volatile III. the non-volatile IV. and the decomposed V. other methods are employed.

The detection of the individual acids is based upon their following characters:—

Free *Carbonic acid* precipitates lime from alkaline solutions, and dissolves it in excess; it is non-inflammable, and extinguishes flame.

Free *hydrosulphic acid* gives the characteristically coloured sulphides with the metals (described under the bases); its smell is peculiar; it is inflammable, being converted, on combustion, into sulphurous acid and water.

The *sulphurous acid* is uninflammable; of peculiar smell; forms an insoluble sulphite with lime; and decomposes hydrosulphuric acid, solid sulphur being liberated.

Free *hydrofluoric acid* has the power of attacking silicic acid and the silicates, forming gaseous fluosilicic acid. If therefore a piece of glass be partly coated with wax, and exposed to the gas given off when a substance is warmed with strong sulphuric acid, it will be etched in those parts which are unprotected, if the original substance contain a fluoride.

Nitric acid. As all nitrates are soluble, nitric acid cannot be precipitated by any base. Free nitric acid oxidises metallic copper, being itself deoxidised, and the formation of red fumes attend such deoxidation. Free nitric acid is also turned brown by the protosulphate of iron. On adding, therefore, strong sulphuric acid to a nitrate and heating with metallic copper, red fumes are given off. If a solution of protosulphate of iron be poured upon another cold portion to which sulphuric acid has been added, a brown ring is formed at the junction of the two liquids.

Hydrocyanic acid. When a cyanide is treated with strong sulphuric acid, hydrocyanic acid is given off. Free hydrocyanic acid combines with sulphide of ammonium, containing an excess of sulphur (over the monosulphide), and forms with it sulphocyanide of ammonium, a substance which, after the excess of sulphide of ammonium is expelled by heat, gives a blood-red colour with the persalts of iron. Hydrocyanic acid forms a white cyanide of silver, which is insoluble in water and acids, but soluble in ammonia. It is decomposed by heat alone.

Hydrochloric and *hydrobromic acids* both form salts with silver which are insoluble in water and acids, but soluble in ammonia. The bromide and chloride of silver are decomposed on being fused with carbonate of soda, the metal being reduced and the bromide and chloride of soda formed. Bromides and chlorides, when heated with

sulphuric acid and binoxide of manganese give off bromine and chlorine respectively.

Hydriodic acid. Iodide of silver is yellow, insoluble in acids, and very difficultly soluble in ammonia. Iodides are decomposed, giving off free iodine when heated with binoxide of manganese and strong sulphuric acid.

Sulphuric acid in solution precipitates baryta from solution as a sulphate, which is insoluble in hydrochloric acid. Sulphates are converted into sulphides by fusion with carbon.

The members of group IV. form baryta and lime, salts which are insoluble in water and ammonia, but soluble in free hydrochloric acid.

Silicic acid in the free state, after drying, is insoluble in water and acids, except hydrofluoric acid. It forms a transparent colourless bead when fused with carbonate of soda. Silicates which are not decomposed by acids give up their bases to carbonic acid when fused with an excess of carbonate of soda; the silicic acid itself combining with the soda to form a basic silicate of soda from which an acid separates the base, leaving the silicic acid, after drying, as an insoluble powder.

Phosphoric acid. Phosphoric acid forms a yellow phosphate of silver, which is soluble in nitric acid and in ammonia. The phosphates of the alkaline earths, and of iron, chromium, and alumina, are soluble in acids, but not in ammonia. Compare magnesia.

Boracic acid. The borates of the alkaline earths, and of iron, chromium, and alumina, are soluble in acids, but not in ammonia. If a borate be treated with strong sulphuric acid, the boracic acid is liberated. Free boracic acid has an alkaline reaction, and gives a characteristic green colour to the flame of alcohol. The borate of silver is soluble in nitric acid.

Chloric acid, like nitric acid, forms an insoluble salt; a chlorate on being ignited gives off its oxygen, and is converted into a chloride.

Oxalic acid forms with lime an oxalate which is insoluble in water, but soluble in acids (excepting acetic acid). Many oxalates on being heated give off carbonic oxide, and are converted into carbonates.

Space will not allow a detailed description of the separation of the acids; moreover they do not admit of a systematic separation, similar to that described with the bases. The following outline may serve to give some idea of the process employed. We will at first suppose that the alkaline earths, alumina, and the oxides of chromium and iron are absent.

I. The substance is treated with dilute hydrochloric acid; if a gas is evolved on warming, it is passed through lime water. A precipitate is formed, both with carbonic and sulphurous acids. The latter is detected by its bleaching power, its peculiar smell, and by its depositing sulphur when mixed with hydrosulphic acid. A piece of paper moistened with a solution of acetate of lead is held in the evolved gas; if it is blackened, hydrosulphic acid is present.

II. Another portion is evaporated to dryness with a fixed alkali, and treated with strong sulphuric acid; the gas, if any is evolved, is tested as before described for hydrocyanic and hydrofluoric acids.

III. Another portion is treated with strong sulphuric acid, and distilled (this is at first done with a small quantity, lest a chlorate be present, in which case the action is attended with explosion), water being placed in the receiver. A portion of the distillate is tested for nitric acid with sulphate of iron and metallic copper as already described. To another portion nitric acid and nitrate of silver are added. If any precipitate is formed, it is collected and treated with dilute ammonia. The insoluble portion is treated with strong sulphuric acid and binoxide of manganese. Iodine is evolved if hydriodic acid was present (iodine would also be evolved on distilling the substance with sulphuric acid). Nitric acid added to the ammoniacal filtrate precipitates the bromide and chloride of silver, in which the halogens are either at once detected in the same manner as was the iodine, or else after combining them with sodium by fusing the silver salts with carbonate of soda.

IV. To another portion, hydrochloric acid must be added (if a precipitate be formed it must be removed by filtration), and then solution of chloride of barium; if a precipitate is formed, sulphuric acid was present.

V. A portion from which the carbonic acid has been expelled is neutralised with ammonia, made acid with acetic acid, and treated with chloride of calcium. If a precipitate is formed, it is oxalate of lime. In this case it is collected, dried, and heated in a closed tube; carbonic oxide is thereby driven off, and may be inflamed; a white carbonate of lime remains, which gives off its carbonic acid when treated with hydrochloric acid. The filtrate from the oxalate of lime is evaporated to dryness, at 212°, with hydrochloric acid. If a residue remains which is insoluble in water, silicic acid is present; this gives a clear glass when fused with carbonate of soda. A portion of the dry residue is moistened with alcohol, treated with sulphuric acid, and inflamed; a green flame shows the presence of boracic acid. To another portion of the dry lime salt, chloride of iron is added, and then acetate of soda in excess. On boiling to expel the liberated acetic acid, phosphate of iron (and subacetate) is precipitated. This is filtered from the chloride of calcium formed, and after washing, decomposed by sulphide of ammonium. The iron remains insoluble as a sulphide; the phosphoric acid is in the filtrate as the phosphate of ammonia, from which a soluble salt of magnesia precipitates the phosphoric acid.

The acids formed by the union of metals with oxygen, such as chromic, manganic, arsenious, &c., are found when the examination for the bases is performed. Moreover, when certain acids are present along with certain bases, and the salts so formed are soluble in hydrochloric acid and other acids, but insoluble in ammonia, it is clear that in the examination for the bases, when ammonia is added to precipitate the oxides of chromium, aluminium, and iron, salts of such a nature will be precipitated along with, or in place of these three oxides. The salts having this property are formed by the union of any of the three acids,—

Phosphoric, Boracic, Oxalic	with any of the bases,	Baryta, Strontia, Lime	Alumina, Oxide of chromium, Sesquioxide of iron,

as also phosphoric acid when in combination with magnesia.

Hence the precipitate obtained by ammonia must be examined for these acids and bases, as well as for the simple oxides of chromium, iron, and aluminium. For this purpose it is dissolved in nitric acid, and treated with an excess of cold caustic potash. If a precipitate is formed the filtrate is boiled, whereby chromium, if present, is precipitated; in the filtrate from the chromium, acetic acid in excess precipitates any phosphate of alumina; and from the filtrate from this, phosphate of soda precipitates the original alumina as a phosphate.

The precipitate got by adding cold caustic potash to the nitric acid solution of the original ammonia precipitate is redissolved in nitric acid, treated with tartaric acid, and then supersaturated with ammonia. If a precipitate (A) is formed, it is owing to the presence of the phosphates or oxalates of the alkaline earths. The precipitate is dissolved in nitric acid, and treated with protonitrate of mercury. A precipitate shows the presence of oxalic acid, which is separated from the mercury by digesting the oxalate of mercury with sulphide of ammonium, and filtering. The filtrate from the oxalate of mercury is saturated with ammonia, which precipitates the original phosphoric acid in combination with mercury; the two are separated by digestion with sulphide of ammonium, and filtration. The filtrate from the phosphate of mercury is examined for baryta, strontia, lime, and magnesia (which, if present, exist now as nitrates), according to the method described among the bases. The filtrate from precipitate A contains the phosphate of iron, and also the nitrate of the iron which was originally precipitated as an oxide. To a portion of this filtrate, acetic acid and then ferrocyanide of potassium are added; the formation of Prussian blue shows the presence of iron. To another portion chloride of ammonium and then sulphate of magnesia are added: the latter precipitates the phosphoric acid as a phosphate of magnesia and ammonia.

In order to test for the non-metallic elements when they are not present in the form of acids, they are in some cases separated by simple solvents, in others made to combine with oxygen, and the so-formed acids examined. Sometimes both methods are united. Free carbon and carbides are converted respectively into carbonic acid and carbonates on heating with oxide of copper. Free sulphur and phosphorus are soluble in bisulphide of carbon: the former is converted into sulphuric, the latter into phosphoric acid on boiling with nitric acid. Phosphides are decomposed by water or alkalies, phosphide of hydrogen being evolved. Compounds of nitrogen, as the nitrides, are decomposed by caustic alkalies, ammonia being evolved. The method of testing for the free gaseous elements is too obvious to need description.

Some salts resist the action of all solvents in the cold. Such are binoxide of tin, sulphate of lead, sulphate of baryta. On fusing such bodies with carbonate of soda, their acids unite with the soda, and since all soda salts are soluble, they may be thus obtained in solution. Thus stannate and sulphate of soda would be formed from the above. The base, when such is present, combines with the carbonic acid, and the so-formed carbonate, after separation from the soluble soda salt of the acid, is dissolved in an appropriate acid.

Quantitative Analysis.—The methods used in determining the quantity of a constituent in a compound substance, are mainly based upon the experience that in all chemical compounds the constituents are united with one another in definite proportions. For it is a consequence of this fact, that if we can unite a constituent A of a compound with any other body B, so as to produce a substance, the definiteness and invariableness of whose composition is established; then, from the amount of the product AB, we may deduce the amount of the substance A contained in the original compound. Thus, if we wish to ascertain the quantity of hydrogen which a substance contains, our object is effected if we can succeed in combining the whole of the hydrogen with oxygen in such a manner as to form water, and in determining the amount of water so produced. Because, from the fact that water consists of eight parts by weight of oxygen to one of hydrogen, one-ninth of the weight of the water found, will be the weight of the hydrogen which the original substance contained. In other words, from the weight of a compound whose constituents are in definite proportions we know the weight of each of its constituents. Hence, in determining quantitatively the amount of a substance present, we have to seek to combine it in such a manner with some other substance, that the resulting compound may so differ in physical property (solubility or insolubility, volatility) from all other bodies present as to admit of perfect separation from them.

But it is also an immediate result of the definite nature of chemical change, in respect to the quantities of the bodies concerned, that from the amount of substance B required to be added to a substance A, in order, only just, but perfectly to complete the chemical change, the quantity of A present may be deduced. As, in most cases of this species of determination, the reagents are used in solution of known strength, and the amounts of solution employed are determined by measure, this kind of quantitative analysis has received the name of Volumetric Analysis, or Analysis by Standard Solutions. (See VOLUMETRIC ANALYSIS.)

The separation of the constituents of a substance by precipitation is the method most frequently employed for their determination, and hence the collection and weighing of precipitates is an operation of very frequent occurrence, and of the greatest importance, in quantitative analysis.

It is evident that all the operations of quantitative analysis must be performed with the utmost nicety of manipulation with respect to cleanliness, avoidance of loss, and thoroughness.

The determination of the weight of a substance is performed on a balance of the most sensible kind,—a balance which will bear fifty grammes on each pan, and which will turn, when so loaded, when an additional milligramme is placed on one of the pans. The weights most usuually employed are grammes and their decimal parts. Milligrammes are usually indicated, not by weights having this absolute value, but by placing a centigramme fashioned of wire at various distances from the fulcrum on one of the arms of the balance, which, for this purpose, is divided into tenths.

In general, when a substance which has been precipitated from a solution and collected on a filter is weighed, it is previously strongly ignited, in order to free it from all traces of adhering moisture; and since the solid substance cannot be separated from the filter without loss, the filter must be burned with the substance. The ash which the filter would leave on being burned alone is thus weighed with the substance estimated; it is necessary, therefore, to know the weight of such ash, and to deduct it from the weight found, in order to get the weight of the substance. On account of the smallness and constancy of its ash, Swedish filtering-paper is ordinarily employed: if a sheet of such paper, of known area, be burned and its ash weighed, the weight of the ash of a circular piece of known diameter can be easily reckoned.

The hypothetical analysis of a substance will give the best idea of the manipulatory processes generally employed. Let us suppose that we have to determine quantitatively the composition of crystallised sulphate of copper ($CuOSO_3+5HO$); that is, to determine quantitatively (1) the water, (2) the sulphuric acid, and (3) the copper. A clean platinum crucible is heated to redness over a smokeless lamp; it is placed, by means of pliers tipped with platinum, while still hot, in a jar closed at the top with a well-fitting plate, and containing some strong sulphuric acid. The crucible is supported over the acid, on an iron triangular tripod, whose legs are cased in glass tubes closed at the bottom, and whose sides, on which the crucible rests, are coated with platinum foil. When the crucible is quite cold, it is weighed. Let its weight be C. About 1·5 grammes of sulphate of copper, which has been recrystallised, powdered very finely, and dried, to remove mechanically adhering water, by being pressed for some hours between folds of blotting-paper, is placed in the crucible, and the whole is weighed. If the new weight be C+S, then S is the weight of the sulphate of copper. The crucible, with the sulphate, is now kept for an hour at a temperature a little below redness. After cooling as before in the dry-air chamber, its weight is found to be C+S−W; then W is the weight of the water which has been driven off, and this is the whole of the water which was contained in the original sulphate.

The sulphate which has thus been deprived of water, but which has lost neither sulphuric acid nor copper, is now transferred without loss into a beaker glass containing distilled water, and the adhering particles of sulphate are washed out of the crucible into the beaker, whose contents are thereon heated to boiling, whereon the whole of the sulphate is dissolved. A clear solution of chloride of barium is gradually added, until fresh portions cause no further precipitation. When the sulphate of baryta so formed has subsided, the supernatant liquid is poured off upon a moistened filter of Swedish paper, and the whole of the filtrate is collected in another beaker. The sulphate of baryta is then washed out of the first beaker on to the filter. When as much liquid as possible has drained through, a stream of boiling distilled water is directed upon the sulphate of baryta from the wash-bottle previously described, until the filter-paper is filled to within about a quarter of an inch of the top; when this has run through, a fresh portion of water is added, and the same process is repeated six or eight times, the whole of the wash-water being collected in the second beaker. The washing is complete when a drop of the wash-water leaves no residue when evaporated on platinum foil. When thoroughly washed, the funnel containing the sulphate of baryta is covered with paper, and set apart in a warm place to dry. The filtrate contains chloride of copper along with the excess of chloride of barium used. The latter is removed by boiling, adding dilute sulphuric acid until further precipitation ceases, filtering and washing as before: the filtrate alone is preserved. The filtrate from the second precipitate of sulphate of baryta is collected in a silver basin, and evaporated at a temperature below its boiling point as it is being collected. When its bulk is reduced to two or three

liquid ounces, an excess of a solution of pure caustic potash is added, and the whole heated for a few minutes to boiling. The copper is thereby completely precipitated as black oxide; this is filtered from the sulphate of potash, and washed as before described. The filtrate need not be kept. The funnel is covered and dried as before.

The crucible, whose weight is C, is now placed upon a sheet of black glazed paper. The filter containing the sulphate of baryta is unfolded, and as much as possible of the sulphate shaken into the crucible. The sides of the paper are rubbed together to remove the adhering sulphate. The filter is folded up again, and, being so rolled together that all the edges are inside, it is wrapped in a piece of platinum wire, set on fire over the lamp, and held over the crucible. It is then held above the lamp until all incandescence has ceased, and perfect whiteness is attained; then being shaken into the crucible, into which all particles which have been spilled are swept from the paper by a feather, the whole is heated for half an hour to redness, allowed to get cold as before, and weighed. Its weight is C + A + M; so that M is the weight of the sulphate of baryta ($BaOSO_3$). From the equivalent of barium being 68·6, that of oxygen 8, and that of sulphur 16, we know that the equivalent of sulphate of baryta is 116·6.

Ba	=	68·6
O	=	8·
S	=	16·
O_3	=	24·
		116·6

That is, 116·6 parts by weight of sulphate of baryta contain 40 of SO_3. Hence the amount of sulphuric acid found in the sulphate of baryta, that is, in the original sulphate of copper, is—

$$M.\ \frac{40}{116{\cdot}6}\left(=\Sigma\right)$$

The oxide of copper is ignited and weighed in the same manner. Let the crucible, filter ash, and oxide of copper, together weigh C + A + N, then N is the weight of the oxide of copper. We have thus found the absolute weights of the water, sulphuric acid, and oxide of copper, contained in a given weight of sulphate of copper. If the analysis has been performed with perfect accuracy, it is evident that the sum of these three quantities should be identical with the weight of the sulphate of copper taken. But in order to compare various analyses with one another in which different quantities of substance have been employed, it is convenient, from the absolute weights so found to deduce the amounts of the various constituents which would be contained in 100 parts, by weight; in other words, to find their per centage amount.

If S grammes contain W grammes of water, Σ of sulphuric acid, and N of oxide of copper, then 100 grammes will contain $W\frac{100}{S}$ of water, $\Sigma\frac{100}{S}$ of sulphuric acid, and $N\frac{100}{S}$ of oxide of copper, and the sum of these should, of course, be 100. In practice, however, this is very rarely the case. Inaccuracies in weighing, imperfect insolubility of precipitates, imperfect washing, inexact determination of equivalents, loss by manipulation, &c., are sources of error which it is impossible wholly to avoid. The exactness of an analysis, that is, the nearness to 100 to which the sum of its per centage constituents amounts, depends of course upon the nature and number of the substances to be determined; an error of two- or three-tenths per cent. in each is generally admissible.

It is impossible to describe fully the methods and precautions used in the quantitative determination of the various elements.

Potassium is estimated as KCl, $PtCl_2$.

Sodium as NaCl, or NaO SO_3.

Ammonium as NH_4Cl, $PtCl_2$, or from the amount of platinum which this salt contains.

Lime as CaO CO_2, derived from the gentle ignition of the insoluble oxalate.

Strontia as $SrOSO_3$, which is insoluble in alcohol.

Baryta as BaO SO_3.

Magnesia as $2MgO\ PO_5$ derived from the ignition of the insoluble $2MgO\ NH_4OPO_5$.

Iron as Fe_2O_3
Aluminium as Al_2O_3
Chromium as Cr_2O_3
Manganese as Mn^3O^4
Zinc as ZnO
Nickel as NiO
Cobalt as Co

Arsenic as AsS_3
Antimony as SbS_3
Tin as SnO_2
Gold, Platinum, Mercury } as metals.
Lead as PbO SO_3
Silver as AgCl
Bismuth as BiO_3
Cadmium as CdO
Copper as CuO.

The acids are estimated—

Hydrochloric, Hydriodic, Hydrobromic, Hydrocyanic } acids as { AgCl, AgI, AgBr, AgCy

Carbonic acid by the loss in weight experienced on its expulsion.

Sulphuric as $BaOSO_3$.

Hydrosulphuric by conversion into sulphuric, as $BaOSO_3$, or as AsS_3.

Boracic as BoO_3.

Silicic as SiO_3.

Phosphoric as $2MgO\ PO_5$, derived from the ignition of the insoluble $2MgO\ NH_4OPO_5$.

Oxalic from the amount of $CaOCO_2$, found on igniting the insoluble $CaO\ C_2O_3$.

Chloric from the amount of chloride formed on igniting its salts.

Nitric from the quantity of Cu it dissolves in the presence of hydrochloric acid.

Sometimes one of two substances which are nearly allied and which occur together, is estimated by deficiency. Thus, if we have a weighed quantity of the mixed chlorides of sodium and potassium, the chloride of potassium contained in the mixture is determined by estimating the amount of KCl, $PtCl_2$ to which it gives rise, the amount of chloride of sodium is the difference between the weight of the mixed chlorides and that of the chloride of potassium. Or again, if we have a mixed chloride and iodide of potassium, the two halogens are combined with silver, and a weighed quantity of the mixed silver salts being taken, is subjected to the action of a stream of dry chlorine. The chlorine replaces the iodine, and the loss experienced thereby in weight is the difference between the iodine which has been driven out and the chlorine which has entered. The quantity of iodine, and hence that of chlorine, may be thence easily calculated.

CHEMICAL COMBINATION. [CHEMICAL AFFINITIES.]

CHEMICAL EQUIVALENTS. The term chemical equivalent is frequently used as synonymous with the expressions *atomic weight* and *combining proportion*; strictly, however, it is by no means synonymous with these terms; since the equivalent of a body may be, and occasionally is, different from its atomic weight or combining proportion. An equivalent of a substance obviously means such a weight or volume of that substance as is required to replace another body in a definite chemical compound. Thus if we take the element hydrogen and combine it with iodine, we find that 1 lb. of hydrogen combines with exactly 126·88 lbs. of iodine. Now if the hydriodic acid thus formed be brought into contact with a sufficient quantity of bromine, the iodine will be expelled and its place occupied by the bromine, of which exactly 79·97 lbs. will have taken the place of the 126·88 lbs. of iodine. The bromine compound may in like manner be decomposed by chlorine, and it is found that only 35·49 lbs. of chlorine are required to replace or expel the 79·97 lbs. of bromine. Finally, oxygen may be made to replace the chlorine when 8 lbs. of oxygen are found to be capable of expelling the whole of the chlorine. It is therefore obvious that 126·88 lbs. of iodine, 79·97 lbs. of bromine, 35·49 lbs. of chlorine, and 8 lbs. of oxygen, are equivalent to each other in chemical combination, but a reference to the table of atomic weights [ATOMIC THEORY], shows that these numbers are also the atomic weights of the respective elements. If, however, we now replace the oxygen contained in the compound last mentioned, with nitrogen, phosphorus, arsenic, or antimony, we find that the weights of these elements required to replace the 8 lbs. of oxygen are respectively 4·7, 10·7, 25, and 43, numbers which do not coincide with the atomic weights or combining proportions of these elements, but which are exactly one-third of those weights. In other words, in these cases the atomic weight of the element is made equal to three times its equivalent number, and we formulate the last-mentioned compounds as follows:—

Ammonia	NH_3
Phosphuretted hydrogen	PH_3
Arsenuretted hydrogen	AsH_3
Antimonuretted hydrogen	SbH_3

The reasons for departing from the general rule in these cases may be thus stated, in the case of nitrogen, and many of them apply also with equal force to the other elements in question:—

1. Because it is found that a given bulk of gaseous ammonia contains three times as much hydrogen as the same bulk of hydrochloric acid (HCl).

2. Because it is found that a given bulk of nitrogen combines with three times as much hydrogen as does the same bulk of chlorine; and that the relative weights of equal bulks of nitrogen, chlorine, and hydrogen are as 14 : 35·49 : 1.

3. Because certain undoubted analogies are concealed if the combining proportion of nitrogen be taken as 4·7, whilst they are rendered evident if the number 14 be adopted.

4. Because in nearly every case the quantity of ammonia which is the agent or resultant of a reaction, contains three atoms of hydrogen or some multiple of three atoms of hydrogen; and consequently fourteen, or some multiple of fourteen parts of nitrogen.

5. Because, in ammonia, the replacement of hydrogen by other bodies takes place definitely in thirds by three successive stages.

6. Because the formulæ of the compounds of nitrogen with oxygen, would be abnormal and without all analogy if the atomic weight of nitrogen were taken at 4·7 whereas the number 14 gives formulæ which, on account of the regular gradations which they exhibit, cause the compounds of nitrogen and oxygen to be very generally selected as illustrations of the law of multiple proportions.

A similar train of reasoning has recently been very ingeniously applied by Williamson, Brodie, and Odling, to carbon, oxygen, sulphur, and some other elements, the atomic weight of which ought, according to these chemists, to be doubled. In the case of carbon this might probably be done with advantage; but the doubling of the atomic weight of oxygen, although it would allow certain classes of organic compounds to be represented by somewhat more simple formulæ, would yet add considerably to the complexity of others. Although these views have not yet been generally adopted, they have received the assent of several of the most eminent chemists. For further details on this subject see an excellent paper by Dr. Odling in the 'Quarterly Journal of the Chemical Society,' vol. xi. p. 107. [ATOMIC THEORY.]

CHEMICAL FORMULÆ. The use of symbols in chemistry to represent elements has given rise to the use of groups of symbols to represent groups of elements. Such groups of symbols are formulæ. Formerly the metals which were then known were represented by the zodiacal signs of the sun and planets; and shortly after the isolation of the great bulk of the non-metallic elements, arbitrary symbols were invented for their representation, and formulæ were constructed by the juxtaposition of these symbols. The clumsiness, for this purpose, of the zodiacal signs, and of those subsequently proposed, has prevented their use. The symbol adopted universally, at present, for an element is the first letter of its Latin name, in those cases where it has been named in the Latin tongue. If, as is the case with most elements, its discovery is of later date, the first letter of the name given to it is employed for its symbol. But, as there are about sixty elements, and only twenty-six letters in the European alphabet, the names of some elements must necessarily commence with the same letter. To obviate the ambiguity which naturally results from this, the symbols of the less important of the elements beginning with the same letter are compounded of the initial letter and some other letter in their names. The first (or only) letter is always written of the capital size, the second is written small.

In a few instances, different names are given to the same element by the Germans, French, and English, and consequently different symbols are used in the three countries. Thus, the French name for nitrogen is azote, and its symbol in that country is Az. The metal which the English call bismuth is called in Germany wismuth, and its symbol is there Wi. The Germans call tungsten, wolfram; and both they and the English symbolise it by W, &c. Fortunately, however, these are almost the only instances where such dissimilarity exists.

In a few instances compound bodies have received special symbols, as well as those built up from the symbols for the elements of which such compounds are formed. The following table shows all the elements which are at present definitely known, with their symbols.

Aluminium	Al	Nitrogen	N
Antimony	Sb	Osmium	Os
Arsenic	As	Oxygen	O
Barium	Ba	Palladium	Pd
Bismuth	Bi	Pelopium	Pl
Boron	Bo	Phosphorus	P
Bromine	Br	Platinum	Pt
Cadmium	Cd	Potassium	K
Calcium	Ca	Rhodium	R
Carbon	C	Ruthenum	Ru
Chlorine	Cl	Selenium	Se
Chromium	Cr	Silicon	Si
Cobalt	Co	Silver	Ag
Copper	Cu	Sodium	Na
Didymium	Di	Strontium	Sr
Erbium	Er	Sulphur	S
Fluorine	Fl	Tantalum	Ta
Glucinum	Gl	Tellurium	Te
Gold	Au	Terbium	Tr
Hydrogen	H	Tin	Sn
Iodine	I	Titanium	Ti
Iridium	Ir	Thorium	Th
Iron	Fe	Tungsten	W
Lanthanum	La	Uranium	U
Lead	Pb	Vanadium	V
Lithium	Li	Yttrium	Y
Magnesium	Mg	Zinc	Zn
Manganese	Mn	Zirconium	Z
Mercury	Hg	Water	Aq
Molybdenum	Mo	Oxalic acid	$\bar{O}$
Nickel	Ni	Tartaric acid	$\bar{T}$
Niobium	No		

One of these symbols, therefore, used alone, denotes an indefinite amount of the element which it represents. But as a consequence of the law of definite chemical combination, when more than one element is present in a chemical compound a more precise meaning attaches itself to such a symbol. It signifies, in such case, one atom or combining proportion of the element. [See ATOMIC THEORY and CHEMICAL EQUIVALENTS.] Thus CO denotes six parts of carbon combined with eight of oxygen, and is consequently the formula of carbonic oxide. When more than one equivalent of an element is in chemical combination, the number of equivalents or atoms is attached above or below to the symbol representing the element. So that CO_2 or CO^2 is the formula for carbonic acid, which contains six parts of carbon to sixteen of oxygen.

A chemical formula of a compound body, which merely gives the elements present and their total respective quantities, is said to be an irrational or *empirical formula*. In many compound bodies, evidence, either analytical or synthetical, points to the existence of a closer union between certain elements or groups of elements than obtains between others. A chemical formula which expresses this more or less thoroughly is more or less a *rational formula*. The purpose of a rational formula, therefore, is to represent the structure of a compound, or the grouping of the elements of which it is composed. The most intimate union of two elements, or two groups of elements, is expressed by the simple juxtaposition of their symbols or formulæ (KCl, chloride of potassium). In cases of less intimate union, a comma is introduced ($NH_4Cl,PtCl_2$, bichloride of platinum ammonium). When two elements or groups are still more loosely combined, they are connected by the plus sign, + ($CuOSO_3 + 5HO$, penthydrated sulphate of copper). When several molecules or groups of elements are concerned, the number of such molecules is represented either by embracing the group in brackets and attaching the number to the bracket, or by placing the number before the group, in which latter case the number is a factor of all the symbols after it as far as the next sign (, or +) of less intimate combination, $Fe_2O_3(SO_3)_3$ Persulphate of iron, or $Fe_2O_3 3SO_3$.

An example will illustrate this.

Aluminium combines with oxygen in the proportion of two atoms of aluminium to three of oxygen, Al_2O_3 (alumina).

Sulphur combines with oxygen in the proportion of one atom of sulphur to three of oxygen, SO_3 (anhydrous sulphuric acid).

Alumina combines with anhydrous sulphuric acid in the proportion of one molecule of alumina to three molecules of sulphuric acid, $Al_2O_3 3SO_3$ (sulphate of alumina).

Again, potassium combines with oxygen in the proportion of one atom of potassium to one of oxygen, KO (potash).

Potash combines with anhydrous sulphuric acid in the proportion of one molecule of potash to one molecule of sulphuric acid, $KOSO_3$ (sulphate of potash).

Further, sulphate of alumina combines with sulphate of potash, in the presence of water, in the proportion of one molecule of the sulphate of alumina to one molecule of sulphate of potash, $KOSO_3$, $Al_2O_3 3SO_3$; and finally, this latter compound salt combines with water in the proportion of one molecule of the compound salt to twenty-four molecules of water, $KOSO_3, Al_2O_3 3SO_3 + 24HO$ (crystallised potash alumina alum). The above is an instance of the representation by a rational formula of the structure of a compound as derived from its synthesis. The empirical formula of the same body would be $KAl_2S_4H_{24}O_{40}$.

Again, if we take borax and heat it, we find that a certain quantity of water is given off. The residue remains so far unchanged that it dissolves in and crystallises with water, giving rise to the original substance. We conclude hence that—

$$\text{Borax} = \Sigma + n\text{HO}.$$

Σ, on being treated with sulphuric acid, gives rise to sulphate of soda $NaOSO_3$, and another body, Σ_1, whence

$$\Sigma = \Sigma_1 + m\text{NaO}.$$

If the substance Σ_1 be heated with sodium, soda NaO is formed, and a new body, Σ_2, appears as a black powder; hence

$$\Sigma_1 = \Sigma_2 + p\text{O}.$$

Σ_2 refuses to be further decomposed; it is therefore an element, and is called Boron. Consequently, borax consists of oxide of sodium and oxide of boron. For the determination of the numbers n, m, and p in the above equations, the reader is referred to the articles ATOMIC THEORY and CHEMICAL EQUIVALENT. The rational formula for borax is

$$\text{NaO BoO}_3\text{HO BoO}_3 + 9\text{HO}.$$

It must, however, be borne well in mind, that all rational formulæ are partial, inasmuch as they cannot express the whole of the molecular arrangements of the bodies to which they refer; and arbitrary, because they cannot but give undue prominence to particular theoretical views and tendencies. A compound body may be divided into different proximate constituents, according to the different substances which act upon it, and according to the different physical conditions which accompany such action; and one and the same body may be constructed synthetically from different groups of elements. Thus, alcohol, when heated to a certain temperature with strong sulphuric acid, gives up water, being converted into ether. Hence it may be viewed as the ethylate of water—

$$\text{HO}, C_4H_5O.$$

But at a higher temperature sulphuric acid transforms alcohol into olefiant gas, or ethylene, depriving it thereby of twice as much water as it did in converting it into ether: whence alcohol may be viewed as olefiant gas and water—

$$2\text{HO}, C_4H_4.$$

Or, synthetically, alcohol may be formed either by acting upon chloride of ethyl with hydrated potash,

$$C_4H_5Cl + \text{KO HO} = C_4H_5\text{OHO} + \text{KCl},$$

or, by dissolving olefiant gas in sulphuric acid, and decomposing the compound with water—

$$C_4H_4 + 2HO\,SO_3 + 2HO = C_4H_4 2HO + 2HO\,SO_3.$$

Certain bodies, which differ widely from one another in their physical properties, may be composed of the same elements in the same proportion. Thus, all the olefines, ethylene, propylene, butylene, &c., consist of 85·71 *per cent.* of carbon and 14·29 *per cent.* of hydrogen. These bodies differ physically as to their densities, as liquids and gases, and as to the temperature at which they pass from the one state into the other. They all combine directly with bromine, and give rise thereby to products having complete chemical analogy with one another. The body thus formed by the union of ethylene with bromine contains for every two atoms of bromine four of carbon and four of hydrogen. The corresponding product from propylene contains six of carbon and six of hydrogen for every two of bromine; that from butylene contains eight of carbon and hydrogen for two of bromine, &c. Whence the formulæ of the bodies are respectively

$$C_4H_4Br_2,\ C_6H_6Br_2,\ C_8H_8Br_2\ \&c.$$

and, consequently, the formulæ of the olefines themselves are—

Ethylene	C_4H_4
Propylene	C_6H_6
Butylene	C_8H_8
Amylene	$C_{10}H_{10}$

Moreover, it is found that the specific gravities of these olefines, in the state of gas or vapour, at the same pressure and temperature, are respectively—

Ethylene	·9784
Propylene	1·467
Butylene	1·926
Amylene	2·68

numbers nearly in the proportion of 4, 6, 8, 10, respectively, showing that in the same volume of the different vapours, the atoms of the two elements are present in numbers proportional to the above. It is thus that the specific gravity of a substance in the gaseous state,—that is, its vapour density,—shows how many atoms (relatively) it contains, and gives thus so far evidence of its rational formula. For the relation between the rational formula of a body and its specific gravity, when in the solid or liquid state, the reader is referred to ATOMIC VOLUME.

CHEMICAL NOMENCLATURE. The experiments of the early chemists soon increased the number of distinct substances to such an extent, as to render at least a crude nomenclature indispensable, in order to define new bodies in such a manner as to enable subsequent experimenters to recognise them and to apprehend something of their nature. Thus, to indicate the analogies which existed between different sulphates, they designated them by the name of *vitriols;* for a similar reason they gave the names *horn silver, horn lead,* &c., and *butter of antimony, butter of bismuth, butter of zinc,* to compounds of chlorine with certain metals: these names indicating the resemblance in appearance which the first bore to horn and the second to butter.

The names of the simple elements have been formed on no definite plan; they have been given according to the choice of their first discoverer, or of the chemist who first described their properties. Many of them, as antimony, strontium, barium, potassium, aluminium, have received their names from substances in which they existed as characteristic constituents, and which were so named before any certain knowledge of their composition existed. On the introduction of the present system of nomenclature, an attempt was made to give to the elements names characteristic of their properties. This idea it was found impossible to carry out systematically; some of the commonest names had been so engrafted in the science that it was found impossible to root them out. Whole classes of the elements, too, have so little that is characteristic, that it would be difficult to find adequately descriptive names. Further, in framing a systematic nomenclature, it is impossible to avoid giving it the impress of the theoretical ideas prevailing at the time. These names become subsequently modified, from the progress of the science and the discovery of new bodies. Hence, a nomenclature, quite rational at its birth, ceases, after some time, to be in harmony with the state of the science. Many of the names given to the elements at the time of the foundation of our present nomenclature, were in accordance with the theoretical views prevailing at the time, and have been found by the further progress of the science to be inappropriate. Thus oxygen, discovered about that time, was named from *οξυς*, acid, and *γεννεω*, to generate, because it was conceived to be the acidifying principle; the subsequent recognition of the non-existence of oxygen in bodies endowed with highly acid properties, and the existence of oxygen in strictly basic compounds, showed the inappropriateness of the name. For the names of the elements, see CHEMICAL FORMULÆ.

Simple bodies are divided into *metalloids* and *metals.* This classification was based, at first, principally on physical characteristics; but the best distinction is that founded on their chemical properties, namely, that metalloids, in uniting with oxygen, generally form acid compounds, whilst metals, in combining with oxygen, generally give rise to bases.

Every binary compound, or compound of two elements, which can be rendered liquid and a conductor of the electric current, is decomposed by the action of a sufficiently powerful battery; one of its elements is attracted to the positive pole, and the other to the negative pole. As opposite electricities attract each other, the *electro-negative body,* or acid element, is that which goes to the positive pole; and the *electro-positive body,* or basic element, is that which goes to the negative pole. The metalloids are consequently, as a general rule, electro-negative bodies, and the metals electro-positive bodies.

To name a binary compound, we enunciate first the name of the electro-negative body, giving to it the termination *ide* or *uret,* and follow it by the genitive case of the name of the electro-positive body: thus, oxide of silver, sulphuret of mercury.

Of binary compounds, by far the most important are those which the elements form with oxygen. They afford the best examples of the principles on which nomenclature is applied. From their properties they may be divided into acids and bases.

Nomenclature of acids. The names of acids are obtained by affixing to the names of the elements, or some abbreviation of those names, the termination *ic.* Thus the combinations of sulphur and of titanium with oxygen are respectively sulphuric and titanic acids. Where an element combines in more proportions than one with oxygen to form an acid, the termination *ous* is applied to that which contains least oxygen: thus we have *sulphurous acid* and *sulphuric acid.* At the time when these rules were established, it was thought that a body could not form with oxygen more than two acid compounds; but subsequently cases were discovered in which the body formed four or five combinations with oxygen. These cases were provided for by the use of the Greek prefixes *υπο* (under) and *υπερ* (above). Thus an acid containing less oxygen than sulphurous acid was called *hyposulphurous acid,* and an acid between sulphurous and sulphuric acid was called *hyposulphuric acid.* In the series of acids which chlorine forms with oxygen, we have *hypochlorous acid* (ClO), *chlorous acid* (ClO_3), *hypochloric acid* (ClO_4), and *chloric acid* (ClO_5); on the discovery of an acid (ClO_7) containing more oxygen than chloric acid, it was termed *hyperchloric,* or briefly, *perchloric acid.* There are, similarly, *periodic* and *permanganic acids.* A class of bodies exists which have acid properties, but in which sulphur is contained in the place of oxygen; thus, AsS_5, AsS_3, CS_2, which are termed respectively, *sulpharsenic, sulpharsenious,* and *sulphocarbonic acids.* Certain elements, as chlorine, sulphur, iodine, form acid compounds with hydrogen. These are respectively termed *hydrochloric, hydrosulphuric,* and *hydriodic acids.*

Nomenclature of Bases.—The compounds of metals with oxygen are generally bases. In accordance with the principle of nomenclature before stated, they are termed *oxides.* In certain cases, metals combine with several proportions of oxygen; these combinations are always in simple ratios, and according to the law of multiple proportions. To the one containing an atom of oxygen for an atom of metal, the term *protoxide* (*πρωτος, first*), or simply *oxide* is applied; and to the others, the terms *sesquioxide, binoxide, teroxide,* according as they contain $1\frac{1}{2}$, 2, or 3 times as much oxygen as is contained in the protoxide. Thus we have MnO, protoxide; Mn_2O_3, sesquioxide; and MnO_2, binoxide of manganese. A similar nomenclature obtains with higher oxides, but these have generally acid properties. For instance, manganese combines with three atoms of oxygen to form a compound (MnO_3) which is termed *manganic* acid. It also combines, in the proportion of 2 equivalents of manganese to 7 of oxygen, to form an acid which is termed permanganic acid. The term peroxide is frequently applied to that oxygen compound which contains most oxygen, if it be not an acid; thus we say indifferently sesquioxide and peroxide of iron.

Certain oxides exist containing less oxygen than the protoxides. These are termed *suboxides:* as Cu_2O, suboxide of copper; Pb_2O, *suboxide of lead.* They are generally not very stable compounds.

The combinations of the other elements are similarly named. The combinations of sulphur, phosphorus, chlorine, carbon, and nitrogen with other elements are termed respectively sulphides, phosphides, chlorides, carbides, and nitrides. The termination *uret* is becoming gradually replaced by *ide.*

Where several combinations of the same elements exist, the same rules are applied as in the case of the oxides. Thus, protochloride of iron, FeCl, and sesquichloride of iron, Fe_2Cl_3; protochloride of tin, SnCl, and bichloride of tin, $SnCl_2$; terchloride of antimony, $SnCl_3$, and pentachloride of antimony, $SbCl_5$.

In the series of combinations which sulphur forms with phosphorus, we have the hemisulphide, P_2S; monosulphide, PS; tersulphide, PS_3; pentasulphide, PS_5; and dodecosulphide, PS_{12}. We have also iodide of copper, CuI; and subiodide of copper, Cu_2I.

Nomenclature of Salts. Acids in combining with bases give rise to ternary compounds which are called salts. To form their names those of the acid and base are combined, so that the name of the first determines the kind, and of the latter the species; the termination *ic* and *ous* of the acid being respectively changed into *ate* and *ite.* Thus, we should say *sulphate of protoxide of iron, sulphite of protoxide of iron, hyposulphate of protoxide of iron,* to express the combinations of sulphurous, sulphuric, and hyposulphuric acid, respectively, with oxide of iron; or the existence of oxygen in the base being supposed, we may say *sulphate of iron, sulphite of iron, hyposulphate of iron.*

In cases in which an acid—for example sulphuric acid—combines

with a sesquioxide as well as with a protoxide of the metal, as is the case with iron, the salts are called respectively *sulphate of protoxide*, and *sulphate of peroxide of iron;* or, more briefly, *protosulphate* and *persulphate of iron*. These two oxides of iron are termed respectively *ferrous* and *ferric oxide*, and these salts it has been proposed to term *ferrous* and *ferric sulphate*. This mode of nomenclature has much that is advantageous, and has been extended to several other cases; thus, the terms *mercurous nitrate*, and *mercuric nitrate*, express respectively the nitrate of protoxide of mercury, and the nitrate of peroxide of mercury.

Where an acid combines with a base in more proportions than one, the principles heretofore described obtain. We have thus *sulphate* and *bisulphate of potash*, to express the combination of 1 and 2 equivalents of sulphuric acid respectively with the base potash; *Oxalate, binoxalate*, and *quadroxalate of potash*, to express respectively the combinations of 1, 2, and 4 equivalents of oxalic acid with 1 equivalent of potash. *Sesquicarbonate of soda* signifies a combination of $1\frac{1}{2}$ equivalents of carbonic acid with 1 equivalent of soda.

Salts containing more base than exists in the neutral salt are termed *basic salts* or *subsalts*. We have *acetate of lead*, and *subacetate of lead; sulphate of iron*, and *tribasic sulphate of iron:* the latter expressing a proportion of base three times that which exists in the neutral salt.

Combinations of water with acids or with bases are termed *hydrates;* thus, *hydrate of potass* (KOHO), *hydrated boracic acid* ($BO_3 3HO$).

Double salts are expressed by the names of the salts of which they consist: the name of the common acid not being repeated. *Sulphate of copper and potash* expresses the combination of sulphate of copper with sulphate of potash; *chloride of platinum and potassium* (KCl, $PtCl_2$) expresses the combination of chloride of platinum with chloride of potassium. Some chemists regard the chloride of platinum as playing the part of an acid, and the above compound is frequently termed *platinochloride of potassium*.

In the present state of organic chemistry, in which new substances and new processes are being discovered daily, it would be impossible to propose any system of nomenclature which could at all claim to be permanent. The difficulties are further enhanced by the great difference of opinion which prevails among chemists as to the constitution of organic compounds. Bodies which have been studied by different chemists, and which admit of being regarded from different points of view, frequently possess several names. Thus, chloroform, C_2HCl_3, may receive different names according as we view it, as $C_2H'''Cl_3$, the chloride of the tribasic radical *formyl*, C_2H''', or as being $C_2 \left.\begin{matrix} H \\ Cl \\ Cl \\ Cl \end{matrix}\right\}$— marsh gas ($C_2H_4$), in which 3 equivalents of hydrogen are replaced by 3 equivalents of chlorine. The nomenclature of organic compounds hence bears, to a certain extent, the impress of the state of transition; and, under these circumstances, it would be impossible in this brief space to do more than briefly indicate, in the most general manner, the application of the principles of nomenclature in certain special important families.

Certain groups of organic compounds, generally consisting of carbon and hydrogen, have the property of entering into combination with elementary bodies, as if they were themselves elements. The names of these compound radicals, as they are termed, are formed by affixing to some name which denotes their origin the termination *yl* (υλη, matter): as, for instance *ethyl*, the radical of ether; *amyl*, the radical of amylic alcohol; *acetyl*, the radical of acetic acid; *benzoyl*, the radical of benzoic acid. The termination *yl* is indifferently used, whether the radical contains oxygen or not.

The compounds of radicals with other substances are named on the same principles as are applied in the case of organic compounds. For example, *chloride of methyl, sulphide of ethyl, nitrate of amyl, hydride of benzoyl, selenium-ethyl, zinc-methyl*, &c.

Certain radicals, which have an electro-negative deportment, such as cyanogen, mellon, &c., give to their combinations the termination *ide*, as *cyanide of ethyl, mellonide of potassium*, &c.

The termination *al* is frequently employed to express the names of bodies which are either homologous with aldehyde or are derived from it. Thus: *butyral, valeral, chloral, bromal*, &c.

The termination *ole* is applied to certain neutral carbo-hydrogens. Ex.: *benzole, cumole, cymole*, &c.

The termination *ine* has been applied to substances of the most heterogeneous nature. Thus we have *hæmatine*, a constituent of the blood corpuscles; *stearine*, the combination of stearic acid with glycerine; *fibrine; inuline*, a modification of starch; *napthaline; salicine*, &c. The terminal *e* is, however, now generally omitted from all such bodies when they do not possess qualities and composition analogous to ammonia.

The termination *ine* has been generally applied to the natural alkaloids extracted from substances of vegetable origin, such as *quinine, atropine*, &c. On the discovery of compounds possessing the closest analogies with these natural alkaloids, the same termination was assigned to them, as *aniline, cyanethine, thialdine*, &c.

A very large number of compounds have been discovered which resemble ammonia, and have hence been called *amide* bases, or *amines*. Viewed as ammonia, in which hydrogen is replaced by certain radicals, they have received a corresponding nomenclature. A compound, NC_4H_7, is ammonia $\left(N\left\{\begin{matrix} H \\ H \\ H \end{matrix}\right.\right)$, in which hydrogen is replaced by ethyl (C_4H_5), and is called *ethylamine*. An ammonia in which hydrogen is replaced by phenyl is called *phenylamine*. The name *bimethylamine*, or *dimethylamine*, is assigned to an ammonia in which 2 eq. of hydrogen are replaced by 2 of methyl (C_2H_3); *ethylophenylamine*, to an ammonia in which 2 eq. of hydrogen are replaced respectively by ethyl and by phenyl; *ethylomethylophenylamine*, to an ammonia in which 3 eq. of hydrogen are replaced respectively by ethyl, methyl, and phenyl.

Certain compounds have a composition analogous to the ammonium salts, and have received corresponding names. Thus, $C_{28}H_{24}NCl =$ $\left.\begin{matrix} C_{12}H_5 \\ C_2H_3 \\ C_4H_5 \\ C_{10}H_{11} \end{matrix}\right\}$NCl corresponds to chloride of ammonium, and is termed chloride of *ethylomethylamylophenylammonium*. Such names are exceedingly unwieldy, but they possess the advantage of indicating the exact composition of the compounds to which they are applied.

In certain natural bases, hydrogen can be replaced by radicals, either simple or compound. Thus there are *chlorocinchonine, methyle, strychnine*, &c.

A large class of organic substances is formed by the substitution of hydrogen by an equivalent quantity of chlorine, bromine, hyponitrous acid, &c. Such compounds are called *substitution products*, and the principles on which they are named is evident from the following examples: *bichlorobutyric acid* ($C_8H_6Cl_2O_4$); *bromobenzole* ($C_{12}H_5Br$); *nitrobenzoic acid* ($C_{14}H_5(NO_4)O_4$); *binitrobenzoic acid* ($C_{14}H_4(NO_4)_2O_4$); *chloromiline* $\left(\begin{matrix} C_{12}H_6Cl \\ N \end{matrix}\right)$; *trichloracetic acid* ($C_4H_3ClO_4$), &c.

CHEMISTRY, from χημεία (*chemeia*). According to Suidas (in voc. χημεία) it was "the making of silver and gold," or what is now more generally known by the name of alchemy. [ALCHEMY.] Suidas adds that Diocletian burnt all the ancient books of the Egyptians on chemistry (as above explained), in order that the Egyptians might no longer be able to acquire wealth by the practice of this art, and thus be encouraged to resist the Romans. We may probably infer from this that cheméia is an Egyptian word; and if so, its resemblance to Cham or Chem, the genuine name of the country, is a confirmation of this supposition as to its origin. But whatever may have been the original meaning of the word, it no longer includes the imaginary process above-mentioned. Various definitions of its present meaning have been given. Gmelin defines chemistry as the science which treats of the combination of dissimilar bodies into homogeneous masses, and of the separation of dissimilar bodies from homogeneous masses.. According to Thomson, "the object of chemistry is to determine the constituents of bodies, and the laws which regulate the combinations and separations of the elementary particles of matter."—'Inorganic Chemistry,' vol. i. p. 1.

The materials composing our globe, when brought into contact under favourable circumstances, are capable of undergoing certain changes, by which their physical properties become modified or entirely altered. The observation of these changes, the discovery and study of the laws which govern them, and the forces or conditions which modify, promote, or retard them, constitute the science of chemistry.

From the very nature of the operations in which man is compelled to engage for his own sustenance, comfort, and defence, as well as from the multitude of changes of the nature just mentioned, which are constantly occurring at the surface of our earth, it is evident that even the most ancient races could not be wholly ignorant of chemical phenomena, although the classification of these phenomena, and the deduction of the laws regulating and governing them, have been almost entirely the work of the past and the present century.

The science of chemistry cannot boast of any noble origin: on the contrary, it sprang from delusion and superstition, and was fostered by deception and credulity; hence its early history presents us with little that is truly interesting, sublime, or admirable. Many attempts have been made to trace the origin of chemistry to Tubal Cain, who, as an instructor of every artificer in brass and iron, is supposed to have had a considerable amount of chemical and metallurgical knowledge. Others attribute it to Hermes Trismegistus, whose son, Mizraim, was said to have first colonised Egypt, and though such statements may call a smile to the lips of those deeply versed in ancient lore and modern archæological research, yet, involved as is the early history of this science in dark obscurity, the Sacred Writings, as well as the relics of the wonderful race that once peopled Egypt, bear strong testimony that they were acquainted with many chemical processes, which they employed for the preparation of colouring matters for their pottery, and in the embalming of their dead. The coloured glass beads with which their mummies are frequently decorated show also that they were not strangers to the art of glass-making. These, and other instances which might be mentioned, do not, however, allow us to conclude that chemistry was known and cultivated at this remote period as a science; on the contrary, its applications were probably only accidental and isolated, being practised by the various workmen empirically, and without any knowledge of the peculiar forces upon which the processes depended. By degrees, however, as

the number of observations increased, and various singular changes and transmutations were effected by the contact of different substances, the complete alteration in physical properties produced by chemical action attracted attention, and no doubt first led to the belief that all forms of matter were mutually convertible into each other, and hence that iron, lead, tin, copper, &c., could be transmuted into gold.

Whether this idea originated with the Egyptian Greeks or the Arabians is uncertain; but its promulgation attracted a host of adventurers to the prosecution of chemical experiments, who, instead of being disheartened by the continual failure of their processes, seemed only to be incited to greater activity by the difficulties met with in the solution of this important problem, which will probably never be proved to be an impossible one. The origin of experimental chemistry cannot be referred to a more remote period than the seventh or eighth century of the Christian era, and the early nomenclature seems to indicate that the Arabians were the most active in its prosecution; for instance, the words alcohol, aludel, alembic, and alcali, are evidently Arabic.

The history of the middle ages furnishes us with many narrations about the transmutations of metals, and the processes and manipulations by which the impostors or dupes pretended to perform them. The alchemists—as these men were called—had three principal objects of pursuit, namely, the philosopher's stone, possessing the property of transforming the baser metals into gold, the universal elixir to cure all diseases and confer immortality, and the universal solvent. The first of these objects was the most eagerly sought after, and it appears almost incredible to us, how large a number of persons became the dupes of the impostors professing to be possessed of the golden secret, since the mere fact of demanding remuneration for its disclosure, by the men who could produce gold in any quantity at pleasure, was a sufficient proof of the dishonesty of their pretensions. Contemporary with these impostors there lived, however, a large number of honest inquirers, who, although stimulated in their researches by a love of gain, were yet conscientious in their experiments and indefatigable in their exertions; to these men the science is incalculably indebted for the accumulation of an immense number of facts, which being isolated, and at that time comparatively uninteresting, would probably have long remained unknown, had not the golden dream of alchemy lent a charm to research, and stimulated these pioneers in the prosecution of their laborious and frequently dangerous experiments.

Though the new substances procured were at first thrown aside, as unworthy of attention, by the disciples of alchemy, yet the methods of preparation were generally preserved, and soon many of them began to receive important applications in medicine and the arts. Thus the importance of chemical inquiry and experiment, *per se*, began to be appreciated, and at the commencement of the seventh century, men of talent and ability devoted themselves to the study of these curious transformations and interesting phenomena. To Lord Bacon, however, chemistry is largely indebted, for perfectly freeing it from the trammels of alchemy which still pertinaciously hung upon it, hindering its development and stunting its growth: he happily described the alchemists as similar to those husbandmen who, in searching for a treasure supposed to be hidden in their land, by turning up and pulverising the soil, rendered it fertile, in seeking for brilliant impossibilities, they sometimes discovered useful realities; and referring to the chemistry of his time, he says, a new philosophy has arisen from the furnaces, which has confounded all the reasoning of the ancients. He first pointed out the value of experiment and observation over the unassisted human powers, and founded a new system of philosophical inquiry, by showing how little could be effected in the interpretation of natural phenomena, even by the strongest intellects, when unassisted by experimental research. Man, as the servant and interpreter of nature, can only discover her sublime truths by close observation and imitation of her operations.

The knowledge possessed of this science before the time of Constantine has been thus summed up by Bergman: "Some general idea may be formed of the state of chemistry in those days, from the consideration of the several subjects of the art with which they seem to have had no acquaintance. Except the acetic, no trace can be discovered of any other acid. The mineral alkali (carbonate of soda) was known to them by the name of nitre; but of the vegetable alkali (potash) they knew little; of the volatile (ammonia) they were altogether ignorant. Of neutral salts they had the marine (common salt), and the ammoniac (chloride of ammonium). Of earthy salts, they had native alum only; and of metallic salts, blue copperas and native green vitriol."

Of earths, they seem to have distinguished the calcareous and argillaceous; and of stones, a very considerable number.

Of inflammable substances, they were acquainted with sulphur, expressed oils, and oils distilled *per descensum*. But they knew no other method of extracting the essential oils than by means of the unctuous. We find no account whatever of spirit of wine or ether.

Of the seven perfect metals hitherto known, they were acquainted with all but platinum; but they were ignorant of the imperfect. Some authors, indeed, make a distinction between tin and white lead, which was perhaps zinc, bismuth, or regulus of antimony. But it is impossible to draw any certain conclusion with respect to this; when even Pliny distinguishes between hydrargyrum and argentum vivum.

Expressions, digestions, and decoctions, were almost the only operations in their chemistry. Perhaps indeed they used some varieties of elixation, evaporation, and inspissation; as likewise of crystallisation, sublimation, calcination, distillation *per descensum*, fusion, liquation, vitrification, and fermentation. From the authorities, therefore, aleady cited, continues Bergman, "it may be naturally inferred, that at the period under consideration the dawn only of chemistry had made its appearance; and that it was rather a collection of unconnected and ill-founded axioms, the result of observation and remarks, than a science established upon the broad basis of an infinite variety of experiments. At this time they were in want also of the proper instruments, and unacquainted with the necessary steps by which the principles of natural bodies can be exactly separated, collected, and properly defined. They were, therefore, without those means so necessary to the evolution of truth, and the construction of a genuine system."—'Physical and chemical Essays,' vol. iii. p. 91.

From the 7th to the 17th century, or what Bergman terms the middle age, many important facts were discovered, and several products were added to the meagre list which has been given. We shall now notice the various new preparations, which include some most important instruments of analysis. It has been mentioned that up to the present period, the acetic acid was the only one known; but several new acids were now added. Basil Valentine described the process for making what he calls oleum vitrioli, a name by which it is commonly yet known, though more correctly called sulphuric acid, from green vitriol, or sulphate of iron; and Dornæus describes another process for preparing the same acid, which, on account of the form of the vessel used in making it, was called oleum sulphuris per campanum. Nitric acid was obtained by Raymond Lully from nitre; his process was much improved by Glauber, who employed, as at the present time, sulphuric acid to decompose the nitre; by this he produced the acidum nitri fumans, or Glauber's spirit of nitre; from common salt the same chemist procured by means of sulphuric acid the spiritus salis Glauberi, since called marine, muriatic, or hydrochloric acid. Aqua regia was prepared by Hollandus by distilling a mixture of nitre and brine with sulphuric acid; this fluid was so named on account of its power of dissolving gold, the king of metals.

Several salts and some alkaline bodies were also discovered, or became more perfectly known, during this period. Geber describes the process of rendering the alkali of tartar (carbonate of potash) caustic by means of lime; he takes some notice also of the carbonate of soda, and he mentions borax. Glauber described the salt which yet bears his name, the sal mirabile Glauberi, or sulphate of soda; he described also what he terms sal secretus, which is sulphate of ammonia. Raymond Lully added some important observations: he mentions the deliquescent property of potash, and the production of the volatile alkali, or ammonia, by putrefaction; and Basil Valentine notices its evolution from sal ammoniac by the fixed alkalies.

To Crollius chemistry is indebted for the preparation, or at any rate for the description, of several saline substances: thus he terms the salt obtained by saturating vitriolic acid with the alkali of tartar, tartarus vitriolatus, a name not yet quite extinct; but he does not appear to have been aware that this salt, when obtained by other processes, was similar in its nature. Crollius also mentions the salt or acid of amber; and Bartholetus, sugar of milk. The digestive salt of Sylvius was also discovered by the chemist whose name it bears: it has since been named muriate of potash: its present appellation is chloride of potassium.

Of the earths in general but little was known, and even that little, Bergman remarks, was unsupported by the principles of chemistry; clay was distinguished from sand, but not by its genuine chemical characters. Except alum, few earthy salts were known. Hollandus describes chloride of calcium under the name of sal ammoniæ fixus.

Among the metals, antimony was described by Basil Valentine in 1490; bismuth by Agricola in 1530; and zinc by Paracelsus also in the 16th century. Bergman says that Schroeder describes the process of reducing arsenic in his Pharmacopœia of 1649; but Brandt first examined it with considerable accuracy in 1733. Many metallic salts were known and examined in this period. Nitrate of silver was called magisterium argenti, vel chrystalli Dianæ; when fused it was, as now, used as a caustic, and was called by Angelo Sala, lapis infernalis. Crollius gave the appellation of luna cornua to chloride of silver; he mentions also mercurius dulcis, or calomel. The binoxide of mercury prepared by nitric acid, he calls Arcanum Corallinum Paracelsi; acetate of tin, sal Jovis; and oxide of antimony, antimonium diaphoreticum.

Basil Valentine gives an account of acetate of lead, under the name of saccharum Saturni, and mentions the butter of antimony, or chloride; and the white precipitate obtained from it by water is called mercurium vitæ by Paracelsus, and pulvis angelicus by Algarotti. That important medicine, the tartrate of potash and antimony, was first used by Mynsicht, and called tartarum emeticum. Basil Valentine and Paracelsus observed, that chloride of ammonium combined and sublimed with some metallic oxides, producing in the case of iron a compound originally called flores martiales. It has been already noticed, that the sulphates of iron and copper were known by the names of green and blue vitriol, and their nature was understood; in

this period the white vitriol, or sulphate of zinc, was made, though its composition was imperfectly elucidated.

That sulphur was known before the age we are now treating of has been already mentioned; but in this period Basil Valentine describes a solution of it in the fixed alkali, potash. Beguinus mentions it as dissolved in the volatile alkali, or ammonia, and Vigenerus suspected that it was composed of phlogiston and vitriolic acid. Basil Valentine mentions the sulphuric and nitric ethers, but very slightly; but Crollius has described distinctly the art of preparing the former. Thaddeus, Villanovanus, and Raymond Lully describe spirit of wine, and the last calls the strongest spirit alcohol, a name which it yet retains; he mentions the separation of the water by means of carbonate of potash, while Basil Valentine prefers lime for the same purpose. Raymond Lully described the aërated volatile alkali, or carbonate of ammonia. Aëriform bodies began to excite attention at this period. Van Helmont noticed some of the properties of what he calls gas sylvestre, or carbonic acid gas; he observes that it is invisible, but that it was fixed in bodies, and he attributes the phenomena of the Grotto del Cane to its presence.

From the middle till towards the end of the 17th century several learned societies were formed. The Academy del Cimento was founded at Florence in 1651, the Royal Society at London in 1660, and the Academy of Sciences at Paris in 1666; these societies greatly promoted and advanced physics and experimental chemistry. In 1700 the Prussian Academy also took its rise, on the model of that of France. Before, however, these societies existed, a curious work was published in 1630 by Jean Rey, a physician of Perigord; it is entitled 'Sur la Recherche de la cause par laquelle Estain et le Plomb augmentent de poids quand on les calcine.' In this work, which excited little or no attention among his contemporaries, the author, without apparently making any experiments, but relying upon those of others, shows that the weight which metals acquire during calcination is derived from the union of air with the metal; he supposes that air is miscible with other bodies besides metals, and states that it may be expelled from water. Rey is generally considered as the person who first showed that air is fixed in bodies during calcination; but in support of this opinion he quotes Libavius, Cardan, and others, as having ascertained the increase of weight in lead by its conversion into a calx.

Newton himself contributed some new and general ideas on chemical phenomena to the Royal Society; he observes that sugar dissolves in water, alkalies unite with acids, metals dissolve in acids, and he inquires whether these effects are not occasioned by an attraction between their particles. Copper dissolved in aquafortis is thrown down by iron. Is not this, he inquires, because the particles of the iron have a stronger attraction for the particles of the acid than those of copper; and do not different bodies attract each other with different degrees of force?

The principal and early chemical investigators of the Royal Society were Boyle, Hooke, and Slare. The first of these was the greatest chemist and one of the most active experimenters of his age; to him the science is indebted for the introduction of tests, or re-agents, for detecting the presence of other bodies; he overturned the idea which was then commonly entertained, that the results of the operation of fire were the real elements of things. Respecting inflammable bodies, acids, alkalies, and combination, he ascertained several important facts. The air pump, which had been invented by Otto von Guericke of Magdeburg, was improved by Boyle and Hooke, and rendered an important instrument in chemical investigations respecting air; they concluded, also, that air was absolutely necessary to respiration and combustion, and that a portion only of the atmosphere was employed in these processes. Hooke, indeed, arrived at the sagacious conclusion, that the part of the air necessary to the above-named processes is the same as that contained in nitre, and that during the chemical process of combustion this matter combines with the burning body.

In 1674, Mayow of Oxford published his tracts on various philosophical subjects. He seems to have been struck with the analogy subsisting between the phenomena of respiration and combustion: many of his conclusions were correct, though some of them were erroneous. He burned a candle under a bell glass, and found the residual air so deteriorated as to be incapable of continuing combustion; he then caused a mouse to breathe a similar quantity of air, and the necessity of its renewal was soon apparent; after this, he put a mouse and a candle together under the same glass vessel, and he found that it lived only half as long as it had existed when alone under the glass. He then reversed the order of experimenting, and endeavoured to fire combustible matter in air which had been spoiled by breathing, and finding no combustion took place, he concluded that "the nitro-aërial particles are absorbed both by the candle and the animal." Mayow's work contains a chapter relating to the "mutual action of salts of a contrary kind," or to chemical combination and decomposition. A great number of new and curious facts are described in this dissertation.

Although a certain degree of similarity is observable in the views of Boyle, Hooke, and Mayow, respecting the operations of combustion and respiration, yet hitherto no theory had been attempted on a broad basis to account for chemical phenomena. But about this period Germany, which still continued the great school of practical chemistry, gained additional credit by the labours of Beccher, who was born at

Spires in 1645; he studied metallurgy and mineralogy with great assiduity; and although he did not greatly add to the collection of chemical experiments, he improved the instruments of research, and rendered manipulation more simple. His opinions were, that the elements of bodies are air, water, and three earths, one of which is inflammable, another mercurial, and another fusible; these three earths, combined with water, he supposed to constitute a universal acid which is the basis of all other acids. He entertained several other notions which are now known to be utterly at variance with the results of experiment; his greatest merit was the contrivance of a theory by which all known facts were connected and deduced from one general principle. This theory was adopted and considerably modified by Stahl, and was by him promulgated in so imposing a form as to be received by the chemical world almost universally for nearly a century. We shall therefore now give a brief account both of this author and his opinions, long known as the Stahlian theory.

George Ernest Stahl was born in the year 1660, at Anspach. The most important of his works is his 'Fundamenta Chymiæ Dogmaticæ et Experimentalis,' which is divided into a theoretical and practical part. The idea that the metals were earthy substances impregnated with an inflammable principle had been advanced by Albertus Magnus. Beccher maintained the existence of this principle, not only as the cause of metallisation, but likewise of combustibility; and Stahl much improved this view of the subject, and supported it by many ingenious and elaborate experiments. To the peculiar principle he gave the name of phlogiston; the doctrine was called the Stahlian theory. It raised the reputation of the author to the highest degree, and placed him in the first rank of chemical philosophers.

In explaining the phlogistic or Stahlian theory, it is to be understood that Beccher and Stahl considered all combustible bodies as compounds; during combustion one of the principles is supposed to be dissipated, while the other remains. Thus when charcoal is burnt, it is entirely dissipated; Stahl therefore supposed that it was phlogiston, or the inflammable principle, nearly pure. By heating charcoal with metals which had been reduced to calces, or what were termed metallic earths, they resumed their metallic appearance and properties; therefore the metals are compounds of metallic earths and phlogiston. Again, by heating Glauber's salt, which is a compound of sulphuric acid and soda, or the fossil alkali, with charcoal, a compound of sulphur and alkali was obtained. Sulphur, therefore, was supposed to be a compound of sulphuric acid and phlogiston. Now, though it had been shown by Boyle that sulphur would not burn without air, and though he had stated that sulphur was contained in the acid, and not the acid in the sulphur, yet Stahl entirely neglected, in forming his theory, the influence of air in producing the phenomena on which it was founded. The first promulgation of the theory overlooked the simple fact which had been before stated, that metals, instead of becoming lighter by being burnt, as ought to have happened had they lost anything, actually become heavier by the operation. Those who afterwards refined upon this theory endowed phlogiston with a principle of levity, and thus the difficulty was for a time removed, but only to be revived with redoubled force; and this difficulty, when it came to be duly appreciated, proved fatal to the theory of phlogiston.

The merits of Stahl are thus briefly stated by Sir H. Davy: "Though misled in his general notions, few men have done more than Stahl, for the progress of chemical science. His processes were, many of them, of the most beautiful and satisfactory kind; he discovered a number of properties of the caustic alkalies and metallic calces, and the nature of sulphurous acid; he reasons upon all the operations of chemistry in which the gaseous bodies are not concerned, with admirable precision. He gave an axiomatic form to the science, banishing from it vague details, circumlocutions, and enigmatic descriptions, in which even Beccher had too much indulged; he laboured in the spirit of the Baconian school, multiplying instances and cautiously making inductions, and appealing in all cases to experiments which, though not of the most refined kind, were more perfect than any which preceded them."

Several chemists of the phlogistic school followed, who contributed to the advancement of chemical science. Caspar Neumann was born at Züllichau, in Germany, in 1682. In 1724 he was appointed professor of chemistry in the Royal College of Physic at Berlin. Dr. Lewis, in the year 1759, published a translation of his works, entitled, 'The Chemical Works of Caspar Neumann, M.D.,' &c. It would perhaps be difficult to mention any very important discovery contained in this work; but there are several facts which, as facts are always valuable, must still give it a place in the library of a chemist.

John Henry Pott was born at Halberstadt, in the year 1692, and died in 1777. On the death of Neumann, in 1737, he succeeded to the chair of practical chemistry. He was a chemist of great learning and industry. The greater part of his works were collected and translated into French in 1759. In his dissertation on bismuth and zinc, he has collected the statements of all former writers, and described their properties with minute accuracy.

In the year 1709, Andrew Sigismund Margraaf was born at Berlin: he died in 1782. He made some valuable experiments on phosphorus, and on the method of extracting it from urine; he first determined the

properties of alumina, demonstrated the nature of soda, and gave an easy process for preparing pure silver from its chloride. His chemical papers, down to the year 1762, were published at Paris, 1762, in two small volumes; but they do not contain all his memoirs.

In 1630 John Kunckel was born in the duchy of Schleswig; he died in 1702. In 1678 he published a treatise on phosphorus, which had been originally discovered in 1669 by Brandt, an alchemist of Hamburg; all that Kunckel knew of its properties was that it was procured from urine, &c., and from this, after some years' application, he succeeded in obtaining it. The remainder of his works, excepting a treatise on glass-making, are not of great importance.

Nicholas Lemery was born at Rouen in 1645, and died in 1715. He was not the author of any very prominent discovery; but his 'System of Chemistry' contained nearly all that was known respecting the science, and the language in which it was written was more simple than that of those who preceded him. He attempted to explain the cause of earthquakes by an experiment which showed the vivid action that occurs when large quantities of iron filings and sulphur are mixed and allowed to act upon each other.

Homberg was born in 1652, in the island of Java. His papers on chemical subjects were numerous; there are, however, but few of them which are likely to excite much attention in the present state of the science, nor did they greatly contribute to enlarge its boundaries. The pyrophorus known by his name was prepared by mixing human fæces and alum, and heating the mixture to redness till it became a carbonaceous powder. It has been since found that carbonaceous matter in preferable forms may be used with the alum, as honey, flour, or gum. The nature of the combustion of this pyrophorus was first explained by Davy.

Henry Louis Duhamel was born at Paris in 1700, and died in 1781. He published many papers on chemical subjects. His chief contribution to the science was that of pointing out the difference between potash and soda, which had been formerly confounded.

Peter Joseph Macquer was born at Paris in 1718, and died in 1784. He first pointed out the existence of arsenic acid, and the nature of several of the salts which it forms with bases; he afterwards published some important experiments on Prussian blue, and such as tended to the discovery of the nature of its colouring ingredient. He made some experiments on platinum, though without any very beneficial results to chemistry. He was the author of a Chemical Dictionary, which has been translated into many languages.

We have mentioned most of the chemists who contributed valuable additions to the science before the introduction of pneumatic chemistry. To speak of them all would require a volume. We now, therefore, approach, or rather commence, a most important era in the history of chemical research and discovery. Hitherto, except what had been done by Rey, Mayow and Boyle, the effects produced by aëriform bodies, and their relation to the phenomena of chemistry, had almost entirely escaped observation; or at any rate they had been but very slightly and imperfectly considered, as shown with respect to the increase of weight which occurs during the calcination of metals, and which was rather attributed to a principle of levity in the phlogiston lost by them, than the acquisition of weight from the air.

Dr. Hales was born 1677, and died in 1761. About 1724 he recommenced the examination of aëriform bodies which had previously engaged the above-named philosophers; he attempted to ascertain the chemical relations subsisting between air and other bodies, and to determine the circumstances under which air is absorbed or extricated by natural proesses. The results which he obtained were curious and important; but, owing to a fundamental error in his ideas, he drew but few inferences which contributed to elucidate the intricate and hitherto imperfectly explored paths of the science. The idea which he entertained of one elementary principle as constituting elastic matter modified by the effluvia of fluid or solid bodies, greatly aided the formation of those more just views which later and more refined experiments have since contributed to unfold. He subjected a vast number of bodies to the action of heat, and obtained gaseous products from them; thus he found that the air which he obtained from wood was fatal to animals; from nitre he procured nearly 200 times its volume of air, and from coal one-third of its weight. He found that oil of vitrol when poured on the iron filings, produced very little air, but that the addition of water occasioned its evolution in large quantity. In no caee, however, were the gaseous products thus procured examined with the attention which might have been expected from the novelty of the results. He also found that when phosphorus was burnt in air, the quantity of air was diminished, and white fumes were produced; but he neither examined the residual air, nor did he inquire into the nature of the white fumes resulting from the combustion of the phosphorus.

The experiments contained in his Statical Essays, published in 1727, were made to prove the transpiration of trees, and also the force with which they imbibe moisture. These experiments are not, however, immediately connected with our present subject.

In 1718 Geoffroy published tables of affinity; and although the affinity has since been discovered to be modified by a variety of circumstances, yet these tables have certainly been of use.

Dr. Black, Professor of Chemistry in Edinburgh, published, in 1756, his researches on calcareous, magnesian, and alkaline substances. He

showed that there existed in these substances an aëriform body, possessing chemical and physical properties, perfectly distinct from the air of the atmosphere; he proved that marble and chalk contained this body capable of an aëriform existence, and that its presence constituted the difference between them and quicklime; he showed also that it was capable of being expelled from earthy and alkaline substances by the action of an acid, and when the air thus set free was collected and examined, he found it to possess the properties of a weak acid.

Great opposition was offered to the new and important conclusions which were promulgated by Dr. Black: thus, among others, Meyer, a German chemist, attempted to prove that limestone became caustic by combining in the fire with a peculiar substance, and not, as Dr. Black had proved, by losing aëriform matter. The loss of weight which the limestone suffered was, however, almost a sufficient proof of the accuracy of Dr. Black's views; and, in a few years from the date of their promulgation, the opinions of Black were universally admitted to be correct.

The existence of an elastic fluid different from that of the atmosphere greatly excited the attention of experimentalists, and they were soon led to inquire whether others might not also exist. The various gases obtained by Hales were now regarded with different views; and, before many more years had elapsed, numerous and peculiar aëriform bodies were discovered by various processes. Dr. Black's experiments on what he termed latent heat are remarkable for their simplicity, and the precision of the inferences drawn from them.

Watt derived great advantage from these experiments in his celebrated improvements on the steam-engine.

About the year 1765, Mr. Cavendish (who was born in 1731, and died in 1810,) discovered and described the properties of inflammable air, since called hydrogen gas; and he invented an apparatus for collecting and examining elastic fluids, which, although extremely simple, has been completely set aside by the more convenient methods proposed by Dr. Priestley. He ascertained the relative densities of fixed air, inflammable air, and common air.

Having stated the general properties of hydrogen gas, he shows that different metals, when dissolved in similar portions of the same acid, afford different quantities of this gas: that zinc yielded more than iron, and iron more than tin—facts which are perfectly consistent with and explained by the doctrine of equivalents; he ascertained the exact proportions of the constituent gases of the atmosphere. His most celebrated discoveries were, however, those of the composition of water and nitric acid; and he first determined the freezing point of mercury.

His character, as a philosopher, is thus sketched by Sir H. Davy: "Cavendish was possessed of a minute knowledge of most of the departments of natural philosophy: he carried into his chemical researches a delicacy and precision which have never been exceeded: possessing depth and extent of mathematical knowledge, he reasoned with the caution of a geometer upon the results of his experiments; and it may be said of him, what perhaps can scarcely be said of any other person, that whatever he accomplished was perfect at the moment of its production. His processes were all of a finished nature; executed by the hand of a master, they required no correction; the accuracy and beauty of his early labours, even, have remained unimpaired amidst the progress of discovery, and their merits have been illustrated by discussion, and exalted by time."

The important discoveries of Dr. Joseph Priestley next claim attention. He was born in 1733, and died in 1804. No person ever commenced a career of discovery under circumstances less likely to ensure success than Dr. Priestley. He was but imperfectly acquainted with chemical science, he had but little leisure, his apparatus was very deficient, he had frequently to invent new modes of operating, and with means which were extremely scanty. All these difficulties he surmounted with indefatigable industry and ingenuity, and to him we owe some of the most important discoveries which have ever been made.

Pneumatic chemistry had, to a certain extent, been studied, as already shown, by Boyle, Mayow, Hales, and especially by Black and Cavendish, when Dr. Priestley began his experiments. His first memoir was published in 1772, and was on the method of impregnating water with carbonic acid gas. This paper was the result of his accidentally living near a brewhouse, in which he had made experiments on the carbonic acid evolved during fermentation. Among the gaseous products which Dr. Hales obtained was that now called nitric oxide, but he did not inquire into its properties. It was again discovered and minutely examined by Dr. Priestley, who applied it to the purposes of eudiometry, a branch of the science which may almost be said to have originated with him, and in consequence of this discovery.

Nitrogen gas had undoubtedly been obtained, but was not examined by Hauksbee, when he passed atmospheric air over ignited metals; Dr. Rutherford also noticed it about 1772, and to him the priority of the discovery is generally assigned. It appears, however, that Dr. Priestley had obtained it, and noticed its properties at least as early, and perhaps sooner, for he gives an account of it in the 'Philosophical Transactions' for that year.

His greatest discovery was that of what he called dephlogisticated

air, now called oxygen gas. This important accession to chemical science was made on the 1st of August, 1774. He procured it by strongly heating red oxide of mercury, formed by the action of heat and air upon the metal, and collecting the gas which was evolved from it. The consequences of this discovery would require a volume for description; it has served as the basis for all that is known respecting the nature of the atmosphere, water, acids, and alkalies; and the nature of combustion has been greatly illustrated by it.

Sulphurous acid, fluosilicic acid, hydrochloric acid, and ammonia were first made known in the gaseous state by Dr. Priestley; he discovered nitrous oxide gas, and first obtained carbonic oxide gas, the nature of which however he mistook. He did not discover hydrogen gas, but his experiments upon it are interesting; he pointed out the existence of carburetted hydrogen gas, though he did not make many experiments upon it.

The action of electricity on various compound gases was examined by him, and he showed that an acid is formed when sparks are passed through a confined portion of atmospheric air: this fact served as the basis of Cavendish's discovery of the composition of nitric acid. In the same way, the increase of bulk which he found to take place by the action of the same agent on ammoniacal gas led Berthollet to determine the nature of it. His experiments on the amelioration of atmospheric air by the process of vegetation are highly curious, and have been repeated and confirmed by subsequent investigations. His work entitled 'Experiments and Observations on different kinds of Air' contains a vast number of experiments, from which various inferences might be drawn, which he seems, in his rapid career of discovery, himself to have overlooked: such are those just mentioned; and the composition of atmospheric air and water might be added to the list.

His additions to the means previously known for experimenting on gaseous bodies have afforded the greatest facilities to those who have followed him: such are the invention of the pneumatic trough, and the substitution of mercury for water in the case of those gases which are soluble iu the latter fluid. To conclude with the observations of Sir H. Davy: "Chemistry owes to him some of her most important instruments of research, and many of her most useful combinations; and no single person ever discovered so many new and curious substances."

The works of Torbern Bergman (born in 1735, died in 1784) have been collected and translated into English. The first paper which he published was in 1774, 'On the Aërial Acid,' now called carbonic acid gas. If the contents of this paper be compared with the previous one of Cavendish on the same subject, it will be seen that the latter had anticipated Bergman on many of the more important facts. No notice, however, is taken of Cavendish's experiments in it. He afterwards published papers on the 'Analyses of Mineral Waters,' and though the methods which he adopted are by no means accurate, they were preferable to any which had been previously used.

He published a paper on oxalic acid, of which however the discovery is said to be due to Scheele. It will be scarcely possible to enumerate even the various papers of Bergman, and much less to give an analysis of their contents. His 'Essay on Electric Attractions' is however a work of importance, and requires a more detailed notice. The intention of the author was to point out the nature of chemical affinity, and to account for the anomalies which that complicated subject appears to present. He adopts it as a principle that chemical combination is the result of an absolute force. Berthollet attempted to show that this conclusion is erroneous, and though it must be admitted that there are various circumstances which modify the action of this power, we are not so nearly without a guide to just conclusions as the experiments and opinions of Berthollet would lead us to admit.

Bergman published tables in fifty-nine columns, in which he showed the relative attraction of bodies, or what he terms elective affinity. As the order of decomposition often varies, according as it is made in the dry way or the moist, each of the fifty-nine columns was divided into two; the first exhibiting the order of decompositions in the moist, and the second in the dry way. He also stated various cases of double decomposition. These tables are constructed upon the now well-known principle, that any substance, whether acid, alkali, or metallic oxide, being placed at the head of a column, and others under it, such substance has the greatest affinity for that next to it, and for the rest, according to the nearness of their place.

It has been already observed, that Bergman's processes for analysing mineral waters were more correct than any which had been previously adopted, and although his experiments on the analysis of precious stones are far removed from perfection, yet they possess the rudiments of the methods which are now adopted. He first proposed the analysing of minerals by combining them with the fixed alkalies, by which they were rendered partially soluble in water, and totally so either in that fluid or in an acid.

He found fulminating gold to yield ammonia; and he explains the detonation to arise from the sudden decomposition of that gaseous body.

The discoveries which next claim attention are those of Charles William Scheele, who was born at Stralsund in 1742, and died in 1786. Like Priestley, Scheele began his experiments under very unfavourable circumstances with respect to apparatus and the means of procuring it.

Scheele, observing that air was requisite to combustion, subjected it to analysis. He found that certain substances, especially what was then termed liver of sulphur, and now sulphuret of potassium, when exposed to a given bulk of air, diminished it to about four-fifths of the original quantity; he found also that the flame of burning sulphur and of hydrogen gas produced the same effect. Without any acquaintance with what Priestley had previously done, he obtained, by various processes, oxygen gas, which he termed empyreal air; and he showed that this air was absorbed by liver of sulphur; and that upon adding fresh empyreal air to that left unacted upon by it atmospheric air was reproduced.

His experiments on the nature of air were followed by some on heat and light, and he gave the name of radiant heat to that portion of it which emanates from hot bodies, and, as he found, in right lines. He observed the blackening effect which is produced by the sun's rays on chloride of silver, and that the violet rays produce this effect most speedily. He made experiments on Homberg's pyrophorus, and showed that ammonia alum is incapable of forming it. In his dissertation on manganese, he made the discovery of chlorine gas, or, as he called it, dephlogisticated marine acid. His essays on fluor spar contained several valuable facts, but he committed the error of supposing that the silica which he obtained in his operations, from the retort, was formed by the combination of water and fluoric acid. He pointed out the difference between plumbago and sulphuret of molybdenum; and he first described the molybdic and arsenious acids, and formed a compound of the latter with oxide of copper, arsenite of copper, which has since been extensively used as a pigment, under the name of Scheele's or mineral green. He made experiments on milk, and sugar of milk; and the acid of the sugar of milk, now called lactic acid, was noticed by him. He gave a method of obtaining citric, tartaric, gallic, and some other vegetable acids; and published essays on tungsten, ether, calomel, benzoic acid, and urinary calculi, all of which contain valuable information.

He particularly examined the colouring matter of Prussian blue, which was nearly his last contribution to chemical science. The subject was one of great difficulty, considering that it involves the agency of nitrogen, which had not long been discovered. He treats the subject, however, with his usual sagacity; and having obtained what is now called prussic or hydrocyanic acid, he stated several of its properties. Besides the discoveries which have been enumerated, it is to Scheele that we are indebted for the first knowledge of baryta and of the character of manganese.

Antoine Laurent Lavoisier was born in Paris in 1743, and died a victim to the revolution in 1794. Although the original discoveries of Lavoisier have less merit than those of Priestley and Scheele, yet his contributions to the science are numerous and important, especially as to what regards its theory. His 'Elémens de Chimie' were published in 1789. In this work he considers heat as a subtile fluid or a material substance, which he calls caloric. He argues that the different forms of matter depend in general upon the quantity of caloric which they contain. His analysis of atmospheric air, though conducted perhaps on more philosophical principles, does not offer so great precision of results as those deducible from the very simple experiment of Priestley; but it must be admitted that they had the merit of settling the question as to the nature of the atmosphere.

Van Helmont, and after him Macquer, had employed the term gas to denote all elastic fluids which differ from atmospheric air. This word Lavoisier also adopted; and as he found that the portion of the atmosphere which supported animal life also entered into the composition of acids, he called it oxygen gas; the other constituent of the air he called, from its fatal effects upon animal life, azotic gas, now called nitrogen, a name derived from its producing nitric acid.

Lavoisier and his coadjutors effected various improvements in chemical nomenclature, most of which remain in use at present. The nature of the diamond had excited the attention of the Florentine Academy as early as 1690; the subject was resumed by Lavoisier, who proved, that when air was excluded it underwent no change; on the other hand, he showed, that by burning it in oxygen gas carbonic acid was formed, and hence he argued, what has since been more strictly demonstrated, that the diamond, in its chemical nature, is similar to common charcoal.

In adverting to the solution of metals in acids, he notices the necessity of their oxidisement previously to it; and hence he argues the probability that the alkaline earths are metallic oxides, the oxygen serving as a bond of union between them and the acids: this sagacious remark was verified by the discoveries of Davy. In his additional observations on the combinations of oxygen, he mentions the conditions necessary for its union with different bodies; the compounds arising from the union of various combustible bodies are also treated of, and those of the acids and some other compound substances. Sir H. Davy remarks, that "Lavoisier must be regarded as one of the most sagacious of the chemical philosophers of the last century; indeed, except Cavendish, there is no other inquirer who can be compared to him for precision of logic, extent of view, and sagacity of induction. His discoveries were few, but he reasoned with extraordinary correctness upon the labours of others. He introduced weight and measure, and strict accuracy of manipulation into all chemical processes. His mind was unbiassed by prejudices; his combinations were of the most

philosophical nature; and in his investigations upon ponderable substances he has entered the true path of experiment with cautious steps, following just analogies, and measuring hypotheses by their simple relation to facts."

It is, however, matter of history, and ought not to be suppressed, that Lavoisier was not content merely to employ the discoveries of others, even without acknowledgment, but that he made a distinct claim to the discovery of oxygen, a claim which Dr. Priestley satisfactorily refuted, by asserting, what might have been contradicted, but which was not, that he had mentioned this gas and the mode of procuring it at the table of M. Lavoisier himself. He makes scarcely any, if any, acknowledgment of the labours of his predecessors, and his friends have claimed for him the discovery of nitrogen gas, previously described by Priestley and Rutherford.

Claude Louis Berthollet (born in 1748, died in 1822) was the author of more than eighty memoirs on chemical subjects. His earlier papers on sulphurous acid, ammonia, and the decomposition of nitre, were published while he was yet a believer in the phlogistic theory, which he zealously defended, but afterwards renounced. One of his most important contributions to chemistry was that of demonstrating, in 1785, the nature and properties of the elements of ammonia. About the same time he made his experiments on the dephlogisticated marine acid of Scheele, which, from experiments well calculated to give rise to the opinion, he supposed to be a compound of muriatic acid and oxygen, and it was called oxygenised muriatic acid. These views, in consequence chiefly of the experiments of Davy, have been shown to be erroneous; and this gas is now called chlorine, and is admitted to have hitherto resisted all attempts at decomposition. It was stated by Scheele, in his experiments on this gaseous body, that, among other properties which it possessed, was that of destroying vegetable colouring matter. In consequence of this remark, Berthollet applied it to the purpose of bleaching, in which it is now most extensively and almost universally used.

The experiments which Berthollet made on prussic acid and its compounds advanced, but did not complete, our knowledge respecting those bodies. In examining the properties of sulphuretted hydrogen, he observed that it possessed acid properties; it was not however by the French chemists admitted to the class of acids, because it was inconsistent with the theory just adopted, that all acids must contain oxygen. Berthollet also discovered fulminating silver, and first employed alcohol as a solvent for obtaining potash and soda in a pure state.

In 1803 Berthollet published a work entitled 'Chemical Statics,' the object of which was to controvert the opinions of Bergman on chemical affinity; but although he pointed out some difficulties attendant upon them, they were by no means refuted. In this work Berthollet also maintained the opinion that quantity may be made to overcome the force of the chemical affinity existing between bodies. There were, however, several points of the argument which he neglected, or with which he was unacquainted; indeed, at the period at which he wrote, the doctrine of definite proportions had not been promulgated,—a doctrine which will explain many of the apparent anomalies that occurred to Berthollet. Indeed, in a discussion with Proust in which the latter had decidedly the advantage, Berthollet asserted that bodies were capable of uniting with each other in all proportions. But whatever may have been the erroneous views of Berthollet in some particular cases, chemistry is greatly indebted to him for many valuable discoveries and minor details; and the application of the bleaching power of chlorine is a practical scientific improvement which has, for its extent and usefulness, scarcely been surpassed.

Louis Bernard Guyton de Morveau was born at Dijon in 1737, and died in 1816. Although the publications of this chemist were very numerous, and contributed much to the extension of the science, yet he was not the author of any very prominent discovery. His papers are scattered through the 'Dijon Mémoires,' 'Journal de Physique,' and 'Annales de Chimie.' There are, however, some circumstances connected with the history of chemistry in which his participation must not be overlooked. In 1787, in conjunction with Lavoisier, Berthollet, and Fourcroy, he published a work in one volume 8vo, entitled 'Méthode de Nomenclature Chimique,' in which the important improvements projected and subsequently adopted are detailed. In 1801 he published a tract, 'Des Moyens de désinfecter l'Air.' For this purpose he used various acids, and especially hydrochloric acid; but he afterwards adopted chlorine, which is now so generally used for the same purpose. The application of these disinfectants was made in 1782, although the history of it was not given to the public till the year above mentioned. He was the author of a considerable portion of the chemical articles in the 'Encyclopédie Méthodique;' and that on 'Acid' has been justly commended for its accuracy, both as to experimental and historical details. [Guyton de Morveau, in Biog. Div.]

Antoine François de Fourcroy was born at Paris in 1755, and died in 1809. This chemist was more celebrated as one of the first authors, if not the earliest, of a treatise on chemistry, and as a lecturer, than as a promulgator of any very great discovery. His chemical work went through several editions, and is in general written with perspicuity and attention to the history of the science. His 'Philosophy of Chemistry' is also a work of considerable merit. As a discoverer, he is to be mentioned as having first shown that the salts of ammonia and magnesia have a tendency to form double salts; and he particularly pointed out the ammoniaco-magnesian phosphate. He ascertained that biliary calculi resemble spermaceti in their nature; and he imagined that muscular flesh is convertible into a fatty substance, which he named adipocire. He published several papers in conjunction with Vauquelin, but what belongs to each it is impossible to tell. It has been supposed that the facts were principally ascertained by Vauquelin, and the account of them written by Fourcroy. Among other papers, they published one giving a method of obtaining baryta from the nitrate by heat; they discovered also the existence of phosphate of magnesia in bones, and of phosphorus in the brain and in the melts of fishes.

It has been mentioned, that the analysis of precious stones had, though imperfectly, been attempted by Bergman: this department of chemistry received vast accessions from the labours of Martin Henry Klaproth, who was born at Wernigerode in 1743, and died in 1817. This chemist introduced into the art of analysis more improvements than we can even allow room to detail. The vast progress which he made in the science will be fully estimated when it is known, that at the time at which he commenced his labours the correct analysis of scarcely any minerals was known, and that he analysed nearly two hundred with so much accuracy that his results have been generally confirmed, whilst the simplicity of his method of operation is greatly to be commended. In 1789 he discovered a new metal in a mineral called pechblende, to which he gave the name of uranium; and in the same year, in analysing the zircon, he found a new earth, which he called zirconia, and which has since been shown by Berzelius to be a metallic oxide. In 1795 he found the same substance in the hyacinth; in this year he also found in the red schorl the same metallic oxide which Gregor had previously met with and called menachine. Klaproth named it titanium, and this appellation is now generally employed. Apparently ignorant of the fact that strontia had been previously described as a peculiar earth, he in 1793 showed the difference between it and baryta, they having been confounded in Germany up to that time. In 1798 he gave an account of tellurium as a new metal, but it had been before noticed by Müller. In 1804 he described a new substance, which he called ochroita. Berzelius and Hisinger considered it a metallic oxide, and called the metal cerium. Besides these more important contributions to science, he made many discoveries of minor importance, which may be found in his 'Analyses,' of which two volumes were published and translated into English. Besides minerals, there will be found analyses of some mineral waters, an account of the effects produced by intense heat upon various minerals, and the details of the methods of analysis, which are extremely valuable and instructive, both as to the nature and method of employing various chemical reagents.

M. Vauquelin was one of the most distinguished analysts of the present century. He was born in Normandy, in what year we know not; but he died in 1829. His analyses were not confined to any particular class of bodies, and he published more and perhaps included a greater variety in his operations than any other chemist; his researches included the three kingdoms of nature, but his greatest discoveries were in the mineral. In the emerald and beryl he found a new earth, to which, on account of the sweetness of the salts which it formed with acids, he gave the name of glucina; but his discovery of chromium, in the state of chromic acid, in the red lead of Siberia, was an era in chemical history. Originally met with in a scarce and valuable mineral, it has since been found in various parts of the earth combined with iron, and in immense quantity; it is largely employed for various uses; in the state of oxide for giving a green to porcelain; in that of acid, combined with oxide of lead, it forms both a fine yellow and orange chromate, which is used in painting and calico printing. It would be in vain to attempt an analysis of Vauquelin's various papers; they are chiefly to be found in the 'Annales de Chimie,' and will amply repay perusal. He was also author of a work entitled, 'Manuel de l'Essayeur,' which he was particularly competent to write, not merely on account of his great skill, but also as being assay-master of the mint. [Vauquelin, in Biog. Div.]

Mr. Smithson Tennant was born in Yorkshire in 1761, and died in 1814. In 1791 he made an experiment, which confirmed the previous statement of Lavoisier as to the composition of carbonic acid. He effected this by passing phosphorus through red-hot carbonate of lime, and he found that the phosphorus was acidified at the expense of the oxygen of the carbonic acid, and that while phosphoric acid was formed charcoal was developed. In 1796 he heated the diamond with nitrate of potash in a gold tube, and he found that the diamond, by combining with the oxygen of the nitric acid, was converted into carbonic acid, and this combined with the potash of the decomposed nitrate to form carbonate of potash. He observed in 1799 that certain limestones, on account of the carbonate of magnesia which they contain, are hurtful to vegetation; he examined the substance known by the name of emery in 1802, and showed that it is a variety of corundum; and in 1804 he discovered two new metals, viz., osmium and iridium, in the grains of native platinum.

John Gottlieb Gahn (born in 1745, in South Helsingland, died in 1818) was the pupil of Bergman. He was particularly skilled in the

use of the blowpipe; and he ascertained that bone is a compound of phosphoric acid and lime. He proved the metallic nature of manganese, and stated the properties of the metal.

The Rev. William Gregor was born in 1762, and died in 1817. In the year 1791 he discovered a peculiar substance in a black sand, found in the parish of Menaccan in Cornwall. This substance was afterwards detected by Klaproth, and by him proved to be a metallic oxide, to the metal contained in which he gave the name of titanium. In 1805 Mr. Gregor described a hydrate of alumina found in Cornwall; he analysed the uranite, and also the arseniate of lead.

Dr. William Hyde Wollaston was born in 1776, and died in 1828. [WOLLASTON, in BIOG. DIV.] His knowledge was not confined to chemistry: he made acoustics and more particularly optics also his study. His first chemical paper on urinary calculi contained much new information on this subject: he showed that the mulberry calculus is oxalate of lime mixed with animal matter; he pointed out a new calculus, which he named cystic oxide, the nature of the triple phosphate, and of the chalk stones formed on the joints of gouty persons. He discovered two new metals in the grains of native platinum, namely, palladium and rhodium; he showed that oxalic acid and potash combine in three different proportions, forming the oxalate, binoxalate, and quadroxalate of that alkali. He pointed out the nature of some small copper-coloured crystals found in the slag of an iron furnace, proving by a series of experiments, in a paper which is a perfect model of conciseness and accuracy, that they were metallic titanium. He perfected the method of rendering platinum available for the purposes of chemistry and the chemical arts, and his 'Scale of Chemical Equivalents,' more effectually elucidated and extended the doctrine of definite proportions than all that had been previously done both by theory and practice. He first showed that the evolution of voltaic electricity is dependent upon chemical action, a fact which has been since amply and ably illustrated by Faraday. His 'Reflective Goniometer' has given to crystallography all the minute accuracy which it previously stood in need of; for it showed that three substances, namely, the carbonate of iron, lime, and magnesia, which were previously supposed to crystallise in rhomboids measuring the same angles, had all different angles. His paper on the finite extent of the atmosphere is replete with curious and acute observations; and he invented some optical instruments, which we need not here particularly describe.

Humphry Davy was born at Penzance, in Cornwall, in 1778, and died in 1829. [DAVY, in BIOG. DIV.] To the researches and discoveries of this justly celebrated chemist it will be impossible to do justice in the space to which we are confined. His first contributions to chemical science were published in 1799, in a work edited by Dr. Beddoes, entitled 'Contributions to Physical and Medical Knowledge.' The first paper is 'An Essay on Heat, Light, and the Combinations of Light,' and the second 'On the Generation of Phos-oxygen (oxygen gas), and on the Causes of the Colours of Organic Beings;' these, although stamped with the mark of genius, are more remarkable for the speculative than experimental nature of their contents. In 1800 he published a work, entitled 'Researches, Chemical and Philosophical; chiefly concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and its Respiration.' In this, which is a work of high merit, he details the effects produced by the respiration of nitrous oxide both on himself and others. The very high reputation which he had acquired by this work was greatly increased by his paper in the 'Philosophical Transactions' for 1807, entitled, 'On some Chemical Agencies of Electricity.' In this paper he showed that the acid and alkali which had before been observed to be developed by galvanic agency were derived from the decomposition of some previously existing salt, and were not formed by the electric action. He arrived at the conclusion, from the numerous experiments described in this paper, that all bodies possessing chemical affinity for each other are in different electrical states, and that the degree of the affinity is proportional to their intensity. By the agency of voltaic electricity he decomposed the alkalies, potash and soda, and obtained from them metallic bodies, to which he gave the names potassium and sodium; he succeeded also in separating metals from lime, baryta, strontia, and lithia; he was not however equally successful in decomposing those earths which have no alkaline properties, as alumina, glucina, yttria, and zirconia, though these have since yielded to other modes of decomposition. In 1807 he also discovered boron, the metalloid of boracic acid.

In 1811 Davy read a paper to the Royal Society, in which he showed that what was called oxymuriatic acid by Berthollet, instead of being, as he supposed, a compound of oxygen and muriatic acid, was, in fact, an undecomposed substance, and therefore must be regarded as an element, and he gave to it the name of chlorine from its green colour. These views, though at first strongly opposed by Berthollet and Dr. Murray, are now universally adopted. In the following years he contributed various important papers to the Royal Society, and among them the following:—On a compound of chlorine and oxygen; on chloride of nitrogen; on iodine; the combustion of the diamond; on the salts called hyperoxymuriatic; on fire-damp, and the means of preventing accidents in mines; and his invention of the safety lamp; a similar, but less successful, form of safety lamp, depending however upon entirely different principles, having been just previously invented by Stephenson. In succeeding years he published various papers on electricity, electro-magnetism, and on a method of preventing the corrosion of copper sheathing; this plan, though based on sound philosophy, failed in its object, from the very unexpected cause of the sheathing being rendered foul. His last paper was in 1819, on the electricity of the torpedo.

In 1812 Davy published the first part of the 'Elements of Chemical Philosophy,' a work which was never completed. It embodied the results of his discoveries, and an account of certain views of the author up to the time at which it appeared. This work bears occasional marks of haste, yet it contains evidence of its emanating from a genius of the highest order.

In concluding this brief sketch, it is hardly necessary to remark that the discoveries alluded to in it placed their author at the head of the science which he illustrated, not merely in England but in Europe; and his fame will rest on the durable base of experimental discovery and great talent for generalisation.

In giving a history of chemistry, it is impossible not to notice the doctrine of definite proportions, or the atomic theory; under which head we have entered pretty fully into the history of its discovery, and mentioned the contributors to its development, whether deceased or living. In that article the discoveries and labours of Wenzel, Dr. Higgins, Mr. Higgins, Richter, Proust, Dalton, Wollaston, Berzelius, Gay-Lussac, and Prout, are detailed so amply as to require no further notice here.

There are still some other subjects which it is necessary to mention, though we cannot allude to all the discoveries which their respective authors have made. In 1803, Sertuerner, a German apothecary, discovered in opium the first of a new class of alkaline bodies, or the vegetable alkaloids, but this discovery excited little notice, till the author published a second paper in 1816; this alkaloid is morphine. Since this time numerous others have been found; they are most of them very active substances, and frequently poisonous. Thus the different kinds of cinchona have yielded amongst others two alkaloids, quinine and cinchonine, to which their virtues are owing: these were discovered by Pelletier and Caventou, in 1820. It has been found that many of the most active vegetable substances, such as hemlock, nux vomica, tobacco, and many others, contain alkaloids.

In 1812, iodine, a peculiar elementary substance, was discovered by M. Courtais, of Paris. The nature of this body was made the subject of numerous experiments both by Davy and Gay-Lussac. Its discovery served the purpose of illustrating and confirming the new views of Davy as to the simple nature of chlorine.

In 1818 Berzelius discovered a peculiar inflammable elementary body, to which he gave the name of selenium. In 1824 he obtained the elementary bases of silica and zirconia; and in 1829 he found a new metal, to which he gave the name of thorium. In 1818 Stromeyer discovered cadmium, a new metal; and in the same year lithium was discovered by Arfwedson; Bussy obtained magnesium from its oxide in 1829, and in 1830 Sefstrom discovered the metal vanadium.

Up to this time the study of organic chemistry had been little cultivated, the difficulties surrounding the analysis and investigation of organic compounds having greatly contributed to retard the progress of knowledge in this direction. These difficulties were to a great extent removed by the early labours of Liebig, who, in conjunction with Berzelius, drew universal attention to this branch of the science, rendering it, even to the present day, the most attractive field of research to the chemical investigator. To these chemists is due the origination and development of the radical theory of organic compounds, a theory, the value of which, in stimulating and directing investigation, and in facilitating the study of organic compounds, can scarcely be overrated. It served as a thread in the daily widening labyrinth of organic bodies, guiding the investigator to new discoveries and generalisations. Still more recently this branch of the science has received a not less important impulse from the labours of Laurent and Gerhardt; the originality of thought and unwearied industry of these chemists render their early death a grievous loss to science.

We cannot better conclude this slight sketch of the progress of chemistry than by adopting the words of Sir H. Davy on a similar occasion:—"To dwell more minutely upon the particular merits of the chemical philosophers of the present age will be a grateful labour for some future historian of chemistry; but for a contemporary writer it would be indelicate to assume the right of arbitrator, even where praise only can be bestowed."

CHEMISTRY, as applied to Agriculture. [RURAL ECONOMY.]

CHENOCHOLIC ACID. The soda salt of this acid is said to be contained in the bile of the goose, but as its composition is not known, its existence as a separate acid is doubtful.

CHEQUE, a written order on a banker by a person who has money in the bank, directing him to pay a certain sum of money to the bearer, or to A. B. or bearer, or to A. B. or order, which is signed by the drawer. In order to exempt this instrument, so nearly resembling a bill of exchange, from the stamp duty imposed in respect of bills, it was required by the Stamp Act of Geo. III. (55 Geo. III. c. 184), still in force, (1) that it be for the payment of money to the bearer on demand, (2) and be drawn upon a banker residing or carrying on business within fifteen miles of the place of issue, (3) that the actual place of issue be stated in the cheque, (4) that it bear date on or before the day of issue, (5) and that it do not direct payment to be made in bills or promissory notes. The Act, 21 Vict. c. 16

imposed a stamp duty of one penny, to be denoted by an adhesive or impressed stamp cancelled with the signature or initials of the drawer, and permitted the instrument to be also drawn payable to order. A later Act permitted it to be negotiated or transferred beyond the distance of fifteen miles from the bank on which it is drawn, subject to a stamp duty of one penny; and the 21 Vict. c. 20, leaving existing enactments unrepealed, imposes a stamp duty of one penny on all cheques indiscriminately.

A cheque may be drawn for any amount not less than twenty shillings, but under that sum it is void; and any person issuing a cheque drawn for a less sum, or on which a less sum remains payable, incurs a penalty. The utmost care, however, should be observed in writing in the amount, to avoid any carelessness which would facilitate fraudulent alterations, otherwise the result of a successful fraud will fall upon the drawer and not upon the banker. Cheques have for a long time formed a considerable part of the circulating medium of the country, being transferable, if payable to bearer, by delivery, or, if to order, by indorsement, and, as they are payable on demand, there is no time when they may be said to be overdue. But it is a rule of law that a cheque should be presented for payment by the holder or his banker when in the same place with the banker on whom it is drawn, within banking hours on the day after the holder received it, or should be despatched by the post of that day, or the then earliest post from the place, when the banker by whom it is payable carries on business at a distance; otherwise all previous holders are discharged from their liability by the undue delay, and even the drawer is not liable if he has suffered loss in consequence thereof through the failure of his banker in the meantime.

The person to whom the amount of a cheque may be validly paid must be the legal holder, the person, namely, who is capable of giving a discharge for the money, otherwise the banker pays it in his own wrong; but where the cheque is drawn payable to order, the banker is exempted by statute from proving that the first indorsement is genuine, if it purport to be the indorsement of the payee. If the drawer, however, or any subsequent holder, cross the cheque with the name of a banker, or with the blank formula, "—— and Co.," the person receiving the money must be a banker, and none but the particular banker, if any is named, in the crossing upon the cheque. Such crossing is, by the 19 & 20 Vict. c. 25, made part of the cheque and may not be obliterated, altered, or added to by any person, except to insert the name of a banker in the blank formula, without rendering the cheque itself thereby void, and the person who fraudulently so alters it liable to be indicted for forgery.

The banker on whom it is drawn is bound to pay the cheque of his customer immediately on presentment, if he has sufficient funds of the drawer, and a refusal, in that case, to do so subjects the banker to an action for damages at the option of the customer, without proof of pecuniary loss accruing to him therefrom. If the banker pays a cheque with a forged signature to it, or if he pays a sum of money exceeding the amount originally written in the cheque, he does so in his own wrong, and is liable to repay either the whole amount or such sum as he has paid in excess of the original amount so fraudulently altered. But in the case of a crossed cheque, if, at the time when it is presented for payment, it does not plainly appear to be or to have been crossed, or such crossing to have been obliterated, added to, or altered, the banker incurs no liability by paying it, or by paying it otherwise than to a banker, or to the banker named in the crossing respectively, unless in so doing he act *malâ fide* or with negligence.

(*Chitty on Bills of Exchange*, 10th ed., by J. A. Russell, LL.B., and David Maclachlan, M.A.)

CHERRY, a valuable fruit, of which great numbers of varieties are known in our gardens; they are all the produce of *Cerasus avium*, or *C. vulgaris* [Cerasus, Nat. Hist. Div.], or of plants obtained by the intermixture of those two original species. Independently of their value as an article of luxury, and as yielding by distillation such liqueurs as Maraschino (so called because the Dalmatian *Maraschi* cherry is employed in its manufacture) and Kirschenwasser, cherries contribute essentially to the support of the poorer classes in some countries, not only in puddings and tarts, but as a principal ingredient in a kind of soup, and as a dried provision for winter. Their timber moreover is valuable for the more common kinds of cabinet-maker's work, and as in favourable soils they grow fast, they often afford to the planter a quick and good return for the outlay of his money. It is however only upon light sharp well-drained soil that the cherry thrives; when planted in stiff and wet soils it grows slowly, gums very much, and falls into a state of incurable bad health. Its varieties are multiplied by budding or grafting, operations best performed upon the common wild cherry, the stones of which are collected by the nurserymen for that purpose. Like all other fruit trees that have been objects of cultivation, the cherry has given rise to a multitude of varieties, from among which it is difficult for any but professed gardeners to know how to make a selection. We should say that for all useful purposes the following are sufficient. The earliest are the Black Tartarian, and the Early Purple Guigne; the Early May, which ripens close about the same time, is not worth cultivation; these are succeeded by the May Duke, the Bigarreau, the Elton, and the Black Eagle; the Late Duke is the latest of the sweet cherries. For puddings there is the Kentish; for preserving in brandy, the Morello; for drying, the Belle de Choisy, the Flemish, and the Kentish. These are amply sufficient for a small garden, and are all good bearers: the Morello only actually requires a wall. If more variety is wished for, the Black Heart and the Downton may be added: and these are all out of the two hundred and nineteen varieties mentioned in the Horticultural Society's valuable Fruit Catalogue which are at all worth cultivating.

CHERUSCI, a celebrated people of ancient Germany, reckoned by Cæsar as of equal importance with the Suevi, who bordered on the Catti and the Chauci, living inland or south of the latter, and near the banks of the Visurgis or Weser. The Cherusci, with their confederated tribes, excited by Arminius, joined the Catti and others in the attack and defeat of Varus and his legions. They were afterwards defeated by Germanicus in the Teutoburg forest, but not subdued. After Germanicus left Germany and the Romans had drawn their legions back to the banks of the Rhine, the Cherusci quarrelled with the Suevi, and afterwards with the Catti, by whom they were conquered and lost much of their original consequence. Under Claudius the Cherusci sent messengers to Rome, to ask, as a king, for one Italicus, of the race of Arminius, who was born at Rome, of German parents. Italicus, however, on his arrival in Germany, was looked upon by many of his countrymen as an alien, and a degenerate descendant of Arminius. He was expelled from his kingdom, but afterwards recovered it with the assistance of the Langobardi. (Tacitus, 'Annot.' xi. 16, 17.) In the time of Tacitus the Cherusci had declined from their former importance, having been overpowered by the Catti and other neighbouring tribes, and were considered as having degenerated. ('German.' 36.) Their last appearance is at the beginning of the 4th century, when they formed a part of the confederation of the Franks.

CHERVIL, a culinary vegetable, the *Scandix cerefolium* of botanists; it is an annual, and a native of the south of Europe; its leaves have a slight aromatic taste, and are used in soups and salads: it is little cultivated.

CHESS is an intellectual game, played on a chequered board of sixty-four squares by two persons, each furnished with sixteen men, eight of which are called *pieces*, and the other eight *pawns*, and moving alternately. One set of men is usually white and the other black. They are as follows:—

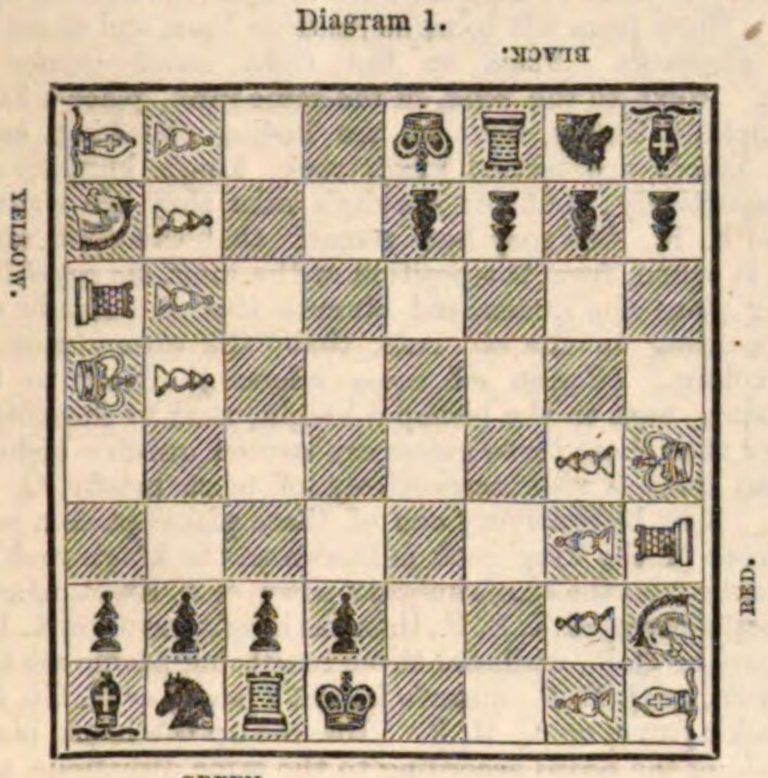
White.		Black.
	King.	
	Queen.	
	Rook or Castle.	
	Bishop.	
	Knight.	
	Pawn.	

Chess is not only distinguished from other games by the large amount of intellect which may be brought to bear upon it, but also by its literature, which would fill a tolerably large library, and this literature is constantly increasing among all nations that practise the game. It consists in the *first* place, of learned inquiries into the origin of the game; *secondly*, of treatises on the game, its laws and institutes, instructions for openings and endings of games, and analyses of the various recognised openings; *thirdly*, of collections of games by distinguished players, usually accompanied by notes pointing out beauties or defects in the play; *fourthly*, of problems or end-games, in which the student is required to give mate in a certain number of moves, or to comply with certain other conditions. A large number of monthly and weekly journals, both in Europe and America, are either wholly or in part devoted to the recording of games and problems and general chess intelligence, together with essays on points which are constantly arising, or which still remain unsettled. *Lastly*, there is much miscellaneous literature, consisting of biographical notices of distinguished players, anecdotes, sketches, tales, and poems. The Latin poem on chess by Vida, bishop of Alba, published at Rome in 1527, under the title of 'Scacchia Ludus,' is well known. The earliest writer in Europe was Cesolis, a Dominican friar, who wrote probably before the year 1200. A Latin edition of his treatise was published in 1473, and a French edition in 1460, from which an English version was made by Caxton, and printed by him at Westminster in 1474, and it enjoys the high distinction of being the first book printed in England with moveable types. Early books on chess are in great request among book-collectors, and they fetch high prices.

History.—It is not in our power, within the limits of this article, to give more than the most meagre sketch of the history of chess. Various nations claim the honour of its invention, and their respective claims are brought together within a readable compass in Mr. Tomlinson's 'Amusements in Chess.' We pass over them the more willingly since Dr. Duncan Forbes, professsor of Oriental languages in King's College, London, in a series of papers originally published in

the 'Illustrated London News,' and collected in a pamphlet for private circulation, has settled the matter in favour of India, adopting the conclusion of Dr. Hyde and Sir William Jones, that "Chess was invented in India, and thence introduced into Persia and other Asiatic regions during the 6th century of our era." The origin of the game is altogether lost, but it seems to have existed for several thousand years before the 6th century of our era. The ancient Hindu game is called "Chaturanga," a term compounded of the two Sanscrit words *chatur* "four," and *anga* a "member" or "component part." The term "shatranj," used by the Persians, Arabs, and Turks, is a corruption of the word chaturanga. The board consisted then, as it does now, of sixty-four squares, but the game was played by *four* persons, each having a king, a rook, a knight, and a bishop (the last being represented by a ship), together with four pawns. The two opposite players were allied against the other two, and the moves were decided by the turn of an oblong die, having four faces, marked with the numbers 2, 3, 4, and 5. The pieces were arranged for play as in the following diagram, in which the green and the black are allied against the red

Diagram 1.



and the yellow. The rook represents the elephant, and the bishop in the corner the ship. The king, rook, knight, and pawns, had the same moves and powers as at present, only the pawn could move but one square at starting. The bishop moved diagonally to any third square, passing over the square next him, which he did not command or attack, and his move was not restrained by any piece in the intermediate square. Another peculiarity was, that not one of the four bishops could attack any of the squares on which the three others were allowed to move. The throwing of the die determined which piece was to be moved. Should the number five turn up, the king or one of the pawns must move; if four, the elephant; if three, the horse or knight; and if two, the ship. The object of each player (the green, for example, or, as we should call him in modern chess, the white) was in the first place to convey the two centre pawns to the opposite end of the board, in order that they might be promoted to the rank of knight or rook, which would nearly double the strength of the player. Another great object was to convey the king, by a series of careful moves, to the square of his ally, the black king. This would give white the command of the allied forces, with a great increase of power. In the mean time, white took every safe opportunity of damaging or exterminating the hostile forces, and having gained his ally's throne and the command of his forces, the main point then was to capture the hostile kings, and gain the "chaturaji," which was equivalent to our checkmate. For minor points and matters of detail, we must refer to Dr. Forbes's papers; but we may say a few words respecting the mode by which the ancient chaturanga probably became gradually changed into the shatranj or mediæval game. In the former, it was a great point with each of the four players to gain possession of his ally's throne, since by that means he had the undivided command of the allied forces. Hence it must often have happened that, after some twenty or thirty moves, the contest remained to be concluded between two players only, a circumstance which was in itself sufficient to have given rise to the mediæval game. There is also evidence that the chaturanga was frequently played by one person only on each side; and as the law and religion of the ancient Hindus strictly prohibited gaming, the use of the die must have been discontinued at a very early age, whereby the game became one of skill and strategy alone. In arranging the allied forces on one side of the board, certain alterations were made. The elephant or rook, and the ship or bishop, were made to change places, whereby the bishop gained more freedom of action. But the most important change was to reduce one of the allied kings to a subordinate situation, called in the Sanscrit "mantri," and in the Persian "farzin," both of which mean monitor or councillor. Thus, by a slight alteration in form, and none in principle, we have the men arranged as in modern chess. This is the game of shatranj, which was introduced into Persia about

the 6th century, and continued to be played in Asia and Europe for nearly 1000 years. The powers of the pieces continued the same as in the chaturanga, and some of their names were preserved in a corrupted form. Thus, the piece next the king is still called in Sanscrit "hasti," and in the Persian "fil" or "phil," which the Western nations converted into "bishop," "fool," "leaper," "alfin," &c. Again, the piece which retains the power of the original elephant, when stationed in the corner, has the ancient name of the ship or chariot; in Sanscrit "roka" or "ratha," and in Persian "rukh," whence our "rook." Among the Hindus the term "ship" was changed into "war-chariot," the latter having the same importance on dry land as the ship in water. So the Persians changed the word "roka" into "rukh," which means a hero or warrior, and also a swift and fierce species of camel. From the Persians the game passed on to the Arabs, in whose language the word "rukh" meant the celebrated fabulous bird. So also the words "scacchi," "echecs," "chess," &c., are not derived from chaturanga, as commonly supposed, but from the Persian "shah" or "king," which is in use to this day among the Arabs and Persians in the same sense as our word "check." So also, when warning the king of danger, we, instead of saying "check," often use the word "king," as do the French "au roi;" while the Germans, with greater exactness, say "schach."

The board on which the chaturanga was played had its squares all of the same colour, nor does any change in this respect appear to have been made when the game was modified into the shatranj. The arrangement of the pieces in the shatranj was exactly as in modern chess. The king, rook, and knight moved precisely as they do now; the farzin, or what we now call the queen, moved only one square diagonally; the fil, which we call bishop, moved two squares diagonally, attacking and commanding only the square next to him but one, and he had no power over the intermediate square. When a pawn reached the opposite extremity of the board, it obtained the rank of farzin only, and not that of any other piece; the pawns could only advance one step at the first move, and this restriction, together with the very limited range of the queen and bishop, required some ten or twenty moves to be made on either side before the actual fight could be said to have begun. Hence, in order to save time and to prevent useless exchanges, it was agreed that the first player should make a number of moves all at once, without however crossing the middle line of the board; after which, the adversary was entitled to play up at once an equal number of counter moves, keeping however to his own half of the board. The Arabs called these preliminary moves "Ta'biyat," which signifies "the drawing up of troops in battle array." When Mr. Lewis visited the celebrated village of Ströbeck, near Halberstadt, he found traces of the mediæval game among the villagers. The pieces having been placed as usual, each party was obliged to play his king's rook's pawn, queen's rook's pawn, and queen's pawn two squares, and the queen to her third square. After this the other pawns could move but one square at a time. The introduction of chess into this village arose from the founding of prizes by a dignitary of the cathedral of Halberstadt, who was exiled to Ströbeck towards the end of the 15th century. His idea was, that by encouraging a game which draws so largely on the mental powers, the villagers would not be attracted by games of chance, nor injured by the vices which usually accompany them. We cannot but think that the example of the good bishop might be adopted in our own day with success.

The transition from the mediæval into the common game of the present day took place about A.D. 1500, and it consisted—first, in extending the power of the bishop, so as to allow him to command the whole diagonal instead of every third square as formerly; secondly, in conferring on the queen the enormous power of the rook and bishop combined; and lastly, in allowing the pawns to advance at the first move either one or two steps. To these improvements may be added that of castling the king, either according to the Italian method, or as now practised. The reasons for these important changes have been variously stated: we have no space for them here, but they are concisely given in Mr. Tomlinson's work. In times of chivalry a game intended to illustrate the art and science of war would be sure to receive favour, and hence chess was thought necessary to complete the education of a gentleman. Italy and Spain became celebrated not only for their players, but also for writers on the game.

The work of Cesolis, already referred to, contained no rules for playing the game. This defect was remedied in the treatises of Vicent and Lucena, published probably about 1495, and more completely in the work of Damiano, a Portuguese, in 1512. This work was written in Spanish and Italian; it contains a few openings, but the greater part of the volume consists of a collection of chess problems, many of which are still regarded as classic. In 1561, Ruy Lopez published in Spanish the 'Book of the Liberal Invention and Art of the Game of Chess.' The author was an ecclesiastic, and for some time enjoyed the reputation of being the best player in Europe; but he underwent the fate of most champions in being deposed after a brief reign. His conqueror was one Leonardo, a Calabrian, whose youthful appearance obtained for him the pseudonym of *Il Puttino*, or "the boy." Leonardo's history is romantic. After having gone through a two years' training preparatory to his contest with Ruy Lopez, he set out for Madrid, but learning that his brother had been taken by the corsairs, he determined to ransom him, and actually won

his ransom by playing chess with the captain of the galley where his brother was chained to the oar. He then proceeded to Madrid, gathering fame on his way, and beat Ruy Lopez in the presence of the Court. Among the celebrated players of the 16th century may be mentioned John Frederick of Saxony, who was playing chess when ordered for execution by Charles V. He finished his game quietly, and prepared himself for his fate: he was, however, released in 1552. Paolo Boi, of Syracuse, was also celebrated: he was considered equal to Il Puttino, and the two players were distinguished by the fanciful title of "the light and lustre of chess." Such players were accustomed to travel from court to court, and from one ducal palace to another, and the honours usually appropriated by the knights of chivalry frequently fell to their share. In 1597 appeared Gianutio's treatise at Turin. It was, however, eclipsed by Salvio's work which appeared in 1604. The games analysed therein lose in value in consequence of the Italian method of castling adopted, namely, by moving the king to his rook's square, and the rook to the king's square. The next writer of importance was Carrera, whose work appeared in 1617; it is a quarto of 600 pages, and has been translated by Mr. Lewis. In the same year Augustus, Duke of Brunswick-Luneburg, published a work under the name of Gustavus Selenus; it is a large quarto of 550 pages, and was printed at Leipzig in 1616. Greco, the Calabrian, was also known in his day as a brilliant player, and specimens of his skill are preserved in his small work, which has also been translated by Mr. Lewis. Early in the 18th century, Captain Bertin obtained fame as a chess player. He invented the opening known as the "three pawns' gambit," which, being adopted by the celebrated player Cunningham, was named by Philidor the "Cunningham gambit." Stamma, a native of Aleppo, published in 1737, a small work containing 100 end-games, many of which may still be consulted with advantage for their ingenious and brilliant play. In 1749, Philidor published in London, in French, his celebrated 'Analysis of the Game of Chess,' a work which has been reprinted or translated in almost every capital of Europe, and although it must be regarded as a compilation it is written in the most agreeable style, and contributed much to promote the practice of the game. This result was further promoted by Philidor's personal qualities, but especially by the then astounding feat of playing blindfold games, which, however useless and not so difficult as is generally imagined, is nevertheless calculated to excite the astonishment of the public. Philidor played three games without seeing any one of the boards. In our own day, a young American of the name of Morphy, has repeatedly played eight games simultaneously without seeing the boards; and another American, named Paulsen, has played twelve under similar circumstances. The marvel is, that when pitted against a number of strong players the blindfold player should be able to carry on eight separate trains of reasoning, and to preserve so much of his skill as to play stronger than his antagonists. In no case does the player play so well blindfold as over the board. Morphy's blindfold games are of a higher order than Paulsen's; so that the eight of the one are more surprising than the twelve of the other. The celebrated French player, De la Bourdonnais, who was accustomed to blindfold play, explained his method of proceeding to consist in representing in his mind the actual board and men, just as anyone may call up the features of an absent friend, so that when sitting with his eyes shut his mental vision was contemplating the shadowy figures. Now, as all persons have this faculty more or less, although one has it more strongly than another, it remains for him in whom it is most strongly developed, by cultivation and exercise, to acquire readiness in the practice. Philidor tells us how he was first led to blindfold play. When quite a lad he used to lie awake at night and play over mentally the games which he had won or lost during the day, and he soon found that he was able to run over the whole of a game, and even to introduce variations, so as to play over what are called "back games." This faculty is most useful in life, namely, the power of realising in the mind the minute details of our pursuits. Sir Isaac Newton attributed the whole of his success to this power of concentration. But to return to Philidor. In 1777, he published a second edition of his work, with considerable additions. The last and perhaps the best English translation of it is by Mr. George Walker. Philidor died in 1795, in London, of grief, on account of the French revolutionists denouncing him as a suspected character, and refusing him a passport to visit his family in Paris.

In 1750 a treatise on chess was published at Modena, and as the author concealed his name he was for many years referred to as "the anonymous Modenese." Dr. Ercole del Rio is the author, and the work has enjoyed considerable celebrity. In 1763, a laborious commentary on it was published by Lolly, and this long continued to be the great authority in chess. Coming nearer to our own day we must mention the treatises of Sarratt, Cochrane, Lewis, Walker, and others, which have had a great influence in making chess popular; but perhaps no treatises have had more influence in this respect than Mr. Staunton's 'Handbook of Chess,' and 'The Chess-player's Companion,' works which place him in the highest rank, both as a player and a writer. The most elaborate work of our own time on chess is by Jaenisch, of which there is an English translation. In concluding this part of our subject, it will be understood that we do not profess to name all the treatises on chess that have appeared, still less to give the

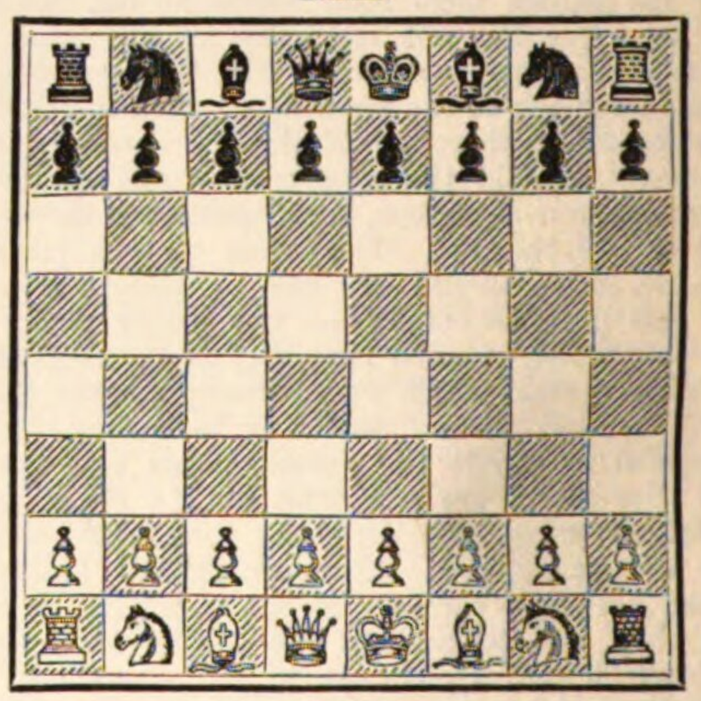
names of celebrated modern players. The reader will find a perfect mine of chess strategy in Mr. Walker's 'Thousand Games,' which include a large number of Philidor's games, the whole of the games in the celebrated matches between McDonnell and De la Bourdonnais, together with games by the best players in Europe, down to the date of its publication in 1844.

Practice of the game.—Conceiving that an article on chess in a Cyclopædia ought to be capable of teaching any one quite ignorant of the game, how to play, we proceed to explain its rudiments. A person in a colony or in a remote country place, into whose hands this work may fall, will thus have the means of acquiring one of the most delightful recreations that it is possible to conceive, and that without any very great amount of study or attempting to become a first-rate player.

Setting up the men.—We have already given the names and forms of the pieces, and will now arrange them in fighting order on the board, our instructions being directed to the placing of the white pieces. Place the board before you with a white square at the right-hand corner, and observe that the lines of squares running upwards are called *files*; those from left to right *ranks* or *lines*, and those which run obliquely *diagonals*. Place on the right hand corner square a white rook. Next to the rook, in the same rank, place a knight, next to the knight a bishop, next to the bishop the king, and observe that these pieces are named king's rook, king's knight, and king's bishop, respectively; but for brevity's sake they are written K. R., K. Kt., and K. B. We may here remark, that this first rank or row of squares is called, from the position of the king, *the royal line*. Next to the king place the queen, and observe that she stands on a white square, according to the old rule, that "the queen must stand on her own colour." (*Regina ad suum colorem.*) Next to the queen place a bishop, next to the bishop a knight, next to the knight a rook, and observe that these three pieces are named queen's bishop, queen's knight, and queen's rook respectively, or more briefly, Q. B., Q. Kt., and Q. R. Now before every one of these pieces place a pawn. The pawn in front of the king' rook is known as the king's rook's pawn, or K. R. P., next comes the king's knight's pawn, or K. Kt. P., next comes the king's bishop's pawn, or K. B. P., then the king's pawn, or K. P., then the queen's pawn, or Q. P., while the three remaining pawns are the queen's bishop's pawn, or Q. B. P., queen's knight's pawn, or Q. Kt. P., and the queen's rook's pawn, or Q. R. P. Now set up the black pieces on the opposite side of the board according to the same directions, making the pieces face each other, and observing that the black queen stands on a black square, and if you have accomplished your task correctly the board will present the appearance shown in the following diagram,

Diagram 2.

BLACK.



WHITE.

which represents the pieces and pawns drawn up in battle array. Next clear off the whole of the men from the board, in order to learn the names of the squares, and the method of moving the pieces. Place a rook on the right hand corner as before, and call this square the king's rook's square. The file of squares opposite to the rook, and next to the right hand edge of the board is named respectively, starting from the first square, king's rook's square, K. R. second square, K. R. third square, K. R. fourth square, K. R. fifth square, K. R. sixth square, K. R. seventh square, and K. R. eighth square. So also the square occupied by the king's knight is called the king's knight's square: the square before him occupied by K. Kt. P. is king's knight's second square: the third square in the file is K. Kt. third, and so on up to the eighth. In like manner we have king's bishop's square, K. B. second, K. B. third, and so on up to K. B. eighth. Next comes king's square, K. second, &c., up to K. eighth. In like manner we have queen's square, Q. B. square, Q. Kt. square, Q. R. square, in each case extending to the eighth as before. The player of the black pieces adopts the same system of nomenclature, his K. R. square is your K. R. eighth, his Q. square is your Q. eighth, your K. square is his K. eighth, Q. B. fourth square is his Q. B. fifth, his K. R. third square is your

K. R. sixth. In this simple manner all the squares on the board are appropriately named, both for the player of the white pieces and for those of the black.

The Moves.—Place a white rook on K. R. square, and observe that this piece can move in any direction parallel to the sides of the board, provided he be not obstructed by the men on either side. Standing alone on the board as he now does he may move to K. R. eighth, from K. R. eighth he may move to Q. R. eighth, thence to Q. R., thence to K. R. home again. We have thus described the longest range of the rook, his shortest range is to K. R. second, or to K. Kt.; but the rook is not compelled to make either his longest or his shortest move; he may move one, two, three, or more squares as occasion may require. Next, place the white king's bishop on his square, and the white queen's bishop also on his square, and observe that they stand on different colours; the move of the bishop is on the diagonals, thus king's bishop can move to K. R. third, thence to Q. B. eighth, thence to Q. R. sixth, and so back again to his own square. So also the queen's bishop can move to K. R. sixth, thence to K. B. eighth, thence to Q. R. third, and so back to his own square. Or he may move one, or two, or three, or more squares according to circumstances. Observe that the king's bishop always moves on the white diagonals, and that the queen's bishop always keeps to the black, so that the two bishops never interfere with each other's actions. But the white king's bishop moves on the same colour as the black queen's bishop, and the white queen's bishop moves on the same diagonals as the black king's bishop, and consequently can be attacked or captured the one by the other. Next place the queen on her own square: her move combines the moves of the rook and the bishop respectively: this tremendous power is supposed to have been conferred during the chivalrous age, as a tribute to the fair sex, and it was not uncommon to call the Persian Farzin, or counsellor, *Fearce* or *Fierge*, which by an easy change passed into *Vièrge*, or the "Virgin;" but the gallantry which conferred on this piece the title of queen, introduced an anomaly into the game, for not only is it unnatural to make a woman the most destructive of warriors; but it is still more so to promote a pawn or foot soldier to the rank of queen, as a reward for having penetrated the enemy's ranks and got to the eighth square. It is not necessary to give any directions respecting the moves of the queen, since we know those of the rook and of the bishop. Place the king on the K. square: his move consists of the shortest move of the queen; that is, he can from his own square move to K. second square, or to Q. second square, or to Q. square, or to K. B. square, or to K. B. second square. At any part of the board where he may happen to be he can thus move one square forwards or backwards to the right or to the left, or upon any one of the four diagonals which surround him; subject, however, to this remarkable condition, that he never approach the opposite king, but always be separated from him by at least one square. The reason for this depends on the fundamental principle of chess, namely, that the person of the king is sacred, and as he can never be captured, so he can never put himself under attack, or "in check" as it is called, which he would do if he occupied the next square to his royal adversary. As the kings cannot attack each other, or remain under attack from any of the pieces or pawns, it is customary to warn your adversary when you attack his king, by calling out "check," and should he be unable to escape the attack, or "get out of check," as it is called, the game is at an end. We now come to describe the knight's move. Place king's knight on his square, and queen's knight also on his square. The move of the knight is curious, it consists of the shortest move of the rook and the shortest move of the bishop, both together; thus, if we play the knight to Kt. second, he can then be moved forward either to K. R. third, or K. B. third; so also the queen's knight taking the shortest move of the bishop can be moved to Q. R. second, and then the shortest move of the rook forwards will take it to Q. R. third. The knight of course gains power when removed from the sides of the board; when king's knight stands at home he can be played to three squares only, namely, to K. R. third, to K. second, or to K. B. third; but when the knight is on K. B. third, or on any other square away from the sides, it will be seen that he can be played to any one of eight squares, so that he is said to "command" these eight squares, and can capture one of the enemy's pieces or pawns placed thereon. The Knight possesses the peculiar privilege of leaping over the other pieces. The pawns have the power of moving one or two steps forwards at pleasure at the first move, thus the king's pawn which stands at K. second, can be moved either to K. third, or to K. fourth, after which it moves one step at a time along its own file, except when it captures, when it moves one step diagonally forwards either to the right or to the left; for example, suppose black have a pawn at his K. fourth, another at his Q. fourth, and a third at his K. B. fourth, and that you have a pawn at your K. fourth; if you have to move you cannot advance the pawn forwards on the king's file, because the path is obstructed by the black pawn at your adversary's K. fourth, but you can capture either his queen's pawn or his king's bishop's pawn, by removing it from the board and placing your own pawn there in its stead: thus the pawns may change their files in advancing forwards, in capturing, but unlike the pieces they have no power to move backwards.

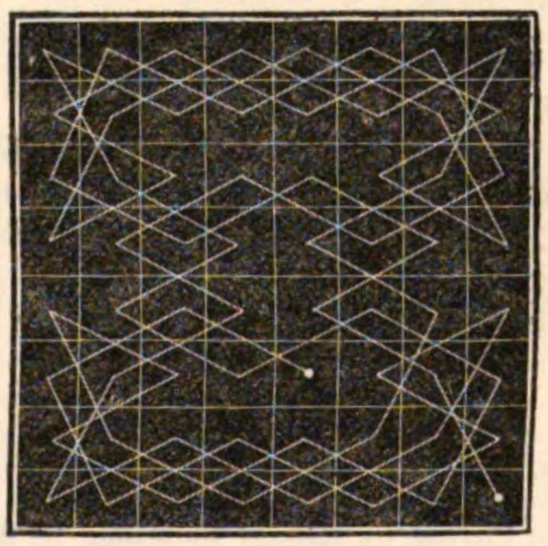
There is a curious condition attached to the privilege of moving the pawn two steps forward at the first move, namely, the power of capturing such pawn by your adversary, provided he have a pawn advanced

to his fifth square on one of the adjacent files; for example, suppose black to have a pawn on his Q. fifth square, and your king's pawn has not yet been moved, if you move the pawn one square, namely, to K. third, it is obvious that the black pawn can capture it. If you play the pawn two steps instead of one, the black pawn can equally capture it, by taking the pawn from the board and playing to K. sixth just as if the white pawn had only moved one step. This is called taking a pawn *en passant*. It is quite optional on the part of the player whose pawn is passed; but if he does not take the pawn, *en passant*, at his next move, he forfeits the privilege, and the two steps taken by the pawn are allowed.

Such are the moves or powers of the pieces. Attempts have been made to express them numerically; taking the pawn as unity, or 1·00, the knight is equal to 3·05, the bishop 3·50, the rook 5·48, the queen 9·94. These numbers must of course vary at different parts of the game. When the board is prepared for play, as in diagram 2, the knights alone, from their leaping power, have value; all the other pieces are blocked in by the pawns, and it is the function of good chess play so to move the pawns as to develop gradually the powers of the pieces. Tables of the respective values of the pieces have been calculated at different points of the game, as in moving over the open board, —in moving over the board when about half cleared by play, &c. Other calculations refer to their values in keeping off the antagonist from a particular set of squares, or in making an attack on two or more different squares, or in dislodging an antagonist from a particular square, or in giving mate without the aid of other pieces, &c. These various tables being collected together, and the mean taken for each piece, we get the average numbers as above. As the king can never be exchanged or captured, he is excluded from the list. It will thus be seen that the knight is worth about three pawns; and that a rook is worth a bishop and two pawns, or five pawns and a half. There appears to be a difference of nearly half a pawn between a bishop and a knight, although in practice a player will exchange one for the other; but in an average state of the board, the bishop can attack the knight in a smaller number of moves than the knight can attack the bishop, and this gives an increased value to the bishop. The bishop and knight are called *minor* pieces, and when a player wins these two for one of his rooks, he is said to "win the exchange."

Before concluding this part of our subject we will give the reader an exercise on the knight's move. It is one of the numerous solutions of the celebrated problem, "to name two different squares on the chess-board of different colours, and placing a knight on one of them, to require him to leap on every square of the board, and to finish his leaps on the other square without stepping twice upon any one square; or, as it is more consisely expressed, "to cover the board with the Kt. in sixty-four moves." This problem has engaged the attention of many distinguished mathematicians, such as Euler, Bernoulli, Mairan, Demoivre, Willis, and Dr. Roget. The last gentleman has discovered a general solution of the problem. ('Philosophical Magazine,' 1840.) An abstract of it, together with other particulars respecting the problem, is given in Mr. Tomlinson's 'Amusements in Chess.'

Diagram 3.



The Game.—We will now play over one of Greco's games, in order to exercise the reader in the moves of the pieces, and in the nomenclature of chess. We shall continue to give instructions to the player of the white pieces, so that the reader will have the board before him, with the men arranged as in diagram 2.

White.	Black.
1. P. to K. fourth square.	1. P. to K. fourth square.

This is the best move on both sides, since it liberates two pieces: namely, the Queen, who has a range of a diagonal of four squares: and K. B., who has a range of one of five; since it is generally found that the player who commands the largest number of squares has the greatest power. After this preliminary move on both sides, you have various methods of opening the game, but we will select what is called the King's Knight's game.

2. K. Kt. to K. B. third.

In this position your knight attacks the black K. P., and black has various modes of defending it; he may do so by playing K. B. to Q. third,

but this would be a bad move, because it prevents Q. P. from moving, and shuts in Q. B. Secondly, he may defend it by playing P. to Q. third; but that shuts in the K. B., although this is less objectionable than in the former case. Thirdly, he may play Q. to K. second, but this more effectually shuts in the K. B. Fourthly, he may defend K. P. by playing P. to K. B. third; but this is a bad move, as we shall see hereafter. Fifthly, he may defend the pawn by Q. Kt. to Q. B. third, which is perhaps his best move.

2. Q. Kt. to Q. B. third.

3. K. B. to Q. B. fourth.

This is a good place for the bishop, since it attacks the weakest point in your adversary's game, namely, his K. B. P., which is defended only by the king.

3. K. B. to Q. B. fourth.

This is a good move on the part of black, for similar reasons.

4. P. to Q. B. third.

This move is to enable you to advance P. to Q. fourth at the next move, which is a very good mode of continuing the attack.

4. Q. to K. second.

This prevents you from playing the move intended, since he would capture your Q. P. with his K. P., whereby your K. P. would be liable to be taken by his Q.; you therefore castle.

5. Castles.

This operation is performed by playing K. R. to K. B. square, and moving the K. to Kt. square. This privilege of moving two pieces at once, and making the king move over two squares, can occur only once on each side during the game. The advantage of it is that you thus place your king in safety, and liberate your rook. There are several conditions attached to castling, which will be noticed hereafter.

5. P. to Q. third.

This further defends the K. P. and liberates the Q. B.

6. P. to Q. fourth. 6. K. B. to Q. Kt. third.

Black prefers to withdraw his bishop to capturing your Q. P. with his K. P.

7. Q. B. to K. Kt. fifth.

The bishop thus attacks the black Q., and she cannot capture him without being retaken by your K. Kt.

7. P. to K. B. third.

Black thus interposes a pawn between the attack of the bishop. It would have been better for him to have interposed K. Kt.; this would have enabled him to castle, with the additional advantage of having brought out another piece. His K. B. P. now attacks your Q. B., and you therefore make him retreat.

8. Q. B. to K. R. fourth. 8. P. to K. Kt. fourth.

Black advances this pawn upon your bishop, thinking to make him retreat to K. Kt. third, but now occurs one of Greco's brilliant strokes of play.

9. K. Kt. takes K. Kt. P.

You remove the black K. Kt. P. from the board, and place your K. Kt. in its stead.

9. P. takes K. Kt.

Black has thus gained a knight for a pawn, and holds the bishop *en prise*, as we say when a piece is liable to be captured by one of the enemy's forces.

10. Q. to K. R. fifth, checking.

You leave your bishop *en prise*, and make an attack on the black king with your queen. Whenever the king is thus threatened, either by a piece or a pawn, you must call out "check," and the game cannot proceed until the king gets out of check. This may be done in one of three ways; *first*, by interposing a piece or pawn; *secondly*, by capturing the attacking piece; or *thirdly*, by moving the king. In the case before us, the only piece that can be interposed is the black queen; but this would render her liable to be captured, either by your Q. or by your K. B. He cannot capture your Q., so that he must move his king.

10. K. to Q. second.

11. Q. B. takes P.

You may now capture the pawn, attacking his Q. with your B. The black Q. escapes from this attack by playing

11. Q. to K. Kt. second.

12. K. B. to K. sixth, checking.

This is another brilliant sacrifice. The king must capture your bishop, since he has no other method of getting out of check.

12. K. takes K. B.

13. Q. to K. eighth, checking.

In this case, the only method of escaping check is by interposing a piece.

13. K. Kt. to K. second.

14. P. to Q. fifth, checkmate.

This finishes the game; for although your Q. is *en prise* to his K. R. and your Q. B. to his Q., these pieces are in no danger so long as his K. is in check; and as he cannot get out of check, he is said to be "check-mated."

This style of play reminds us of some complimentary lines addressed to Greco, in the *Mercure Galant*, for June, 1683:—

"A peine dans la carrière
Contre moi tu fais un pas,
Que par ta démarche fière
Tous mes projects sont à bas:
Je vois dès que tu t'avances,
Céder toutes me défenses,
Tomber tous mes champions;
Dans ma resistance vaine,
Roi, Chevalier, Roc et Reyne,
Sont moindre que tes Pions."

Laws of the Game.—The reader is now in a condition to study what are called the "Laws of the Game." These include institutes and definitions, as well as laws; but as they were revised some years ago by the London Chess Club, and adopted by the other clubs, both in this country and abroad, and authoritatively inserted in Mr. Staunton's 'Handbook of Chess,' we give them with only such alterations as appear to us to be necessary to correct the sense and the grammar. Our alterations are printed in italics. There are several points in which these laws are defective and tautological; Jaenisch and Heydebrand have published treatises in which their anomalies are elaborately discussed, and suggestions made for their revision and improvement. On these suggestions Staunton drew up a new code of laws, which he submitted to the British Chess Association at the close of its meeting at Leamington, in 1855. The meeting appointed a committee to discuss the matter with Mr. Staunton, and present their report, containing a copy of the new laws, to Lord Lyttleton, at the next annual meeting of the Association. The committee, consisting of Rev. W. Wayte, and Messrs. Löwenthal, Ingleby, and Tomlinson, met several times at the St. George's Chess Club, London, and agreed on their report, but it has not yet appeared.

THE LAWS OF CHESS.

I. The Chess-board must be so placed that each player *have* a white corner square nearest his right hand. If the board have been improperly placed, it must be adjusted, provided *four* moves on each side have not been played, but not afterwards.

II. If a piece or pawn be misplaced at the beginning of the game, either player may insist upon the mistake being rectified, if he discover it before playing his fourth move, but not afterwards.

III. Should a player at the commencement of the game omit to place all his men on the board, he may correct the omission before playing his fourth move, but not afterwards.

IV. If a player, undertaking to give the odds of a piece or pawn, neglect to remove it from the board, his adversary, after four moves have been played on each side, has the choice of proceeding with, or recommencing the game.

V. When no odds are given, the players must take the first move of each game alternately, drawing lots to determine who shall begin the first game. If a game be drawn, the player who began it has the first move of * the following one.

VI. The player who gives the odds has the right of moving first in each game, unless otherwise agreed. Whenever a pawn is given, it is understood to be always the King's Bishop's Pawn.

VII. A piece or pawn touched must be played, unless, at the moment of touching it, the player say "*J'adoube*," or words to that effect; but if a piece or pawn be displaced or overturned by accident, it may be restored to its place.

VIII. While a player holds the piece or pawn he has touched, he may play it to any other than the square he took it from, but having quitted it, he cannot recall the move.

IX. Should a player *touch* † one of his adversary's pieces or pawns, without saying "*J'adoube*," or words to that effect, his adversary may compel him to take it; but if it cannot be legally taken, he may oblige him to move the King; should his King, however, be so posted that he cannot be legally moved, no penalty can be inflicted.

X. Should a player move one of his adversary's men, his antagonist has the option of compelling him *to do one of three things*—1st, to replace the piece or pawn and move his *own* King; 2nd, to replace the piece or pawn and take it; 3rd, to let the piece or pawn remain on the square to which it had been played, as if the move were correct.

XI. If a player take one of his adversary's men with one of his own that cannot take it without making a false move, his antagonist has the option of compelling him to take it with a piece or pawn that can legally take it, or to move his own piece or pawn which he touched.

XII. Should a player take one of his own men with another, his adversary has the option of obliging him to move either *of them*.

XIII. If a player make a false move, that is, play a piece or pawn to any square to which it cannot legally be moved, his adversary has the choice of *one of* three penalties: namely, 1st, of compelling him to let the piece or pawn remain on the square to which he played it; 2nd, to

* Staunton has *or*. † Staunton has *take*.

move *it* correctly to another square; 3rd, to replace the piece or pawn and move his King.

XIV. Should a player move out of his turn, his adversary may choose whether both moves shall remain, or the second be retracted.

XV. When a pawn is first moved in a game, it may be played one or two squares; but in the latter case the opponent has the privilege of taking it *en passant* with any pawn which could have taken it had it been played one square only. A pawn cannot be taken *en passant* by a piece.

XVI. A player cannot castle in the following cases: —

1. If the King or Rook have been moved.
2. If the King be in check.
3. If there be any piece between the King and *the* Rook.
4. If the King pass over any *square that is* attacked by one of the adversary's pieces or pawns.

Should a player castle in any of the above cases, his adversary has the choice of *one of* three penalties, namely, 1st, of insisting that the move remain; 2nd, of compelling him to move the King; 3rd, of compelling him to move the Rook.

XVII. If a player touch a piece or *a* pawn that cannot be moved without leaving the King in check, he must replace the piece or pawn and move his King; but if the King cannot be moved, no penalty can be inflicted.

XVIII. If a player attack the adverse King without saying "Check," his adversary is not obliged to attend to it; but if the former, in playing his next move, were to say "Check," each player must retract his last move, and he that is under check must obviate it.

XIX. If the King *have* been in check for several moves, and it cannot be ascertained how it occurred, the player whose King is in check must retract his last move, and free his King from the check; but if the moves made subsequent to the check be known, they must be retracted.

XX. Should a player say "Check," without giving it, and his adversary in consequence move his King, or touch a piece or pawn *in order* to interpose *it*, he may retract such move, provided his adversary have not completed his *next* * move.

XXI. Every pawn which has reached the eighth or last square of the chess-board must be immediately exchanged for a Queen or any other piece the player may think fit, even though all the pieces remain on the board. It follows therefore that he may have two or more Queens, three or more Rooks, Bishops, or Knights, *at the same time on the board*.

XXII. If a player remain at the end of the game with a Rook and *a* Bishop against a Rook, with both Bishops only, with Knight and Bishop only, &c., he must check-mate his adversary in fifty moves on each side at most, or the game will be considered as drawn; the fifty moves *to* commence from the time *when* the adversary gives notice that he will count them. *This* law holds good for all other check-mates of pieces only, such as Queen or Rook only, Queen against a Rook, &c., &c.

XXIII. If a player agree to checkmate with a particular piece or pawn, or on a particular square, or engage to force his adversary to stale-mate or check-mate him, he is not restricted to any number of moves.

XXIV. A stale-mate is a drawn game.

XXV. If a player make a false move, castle improperly, &c., &c., the adversary must take notice of such irregularity before he touches a piece or pawn, or he will not be allowed to inflict any penalty.

XXVI. Should any question arise, respecting which there is no law, or in case of a dispute respecting any law, the players must refer the point to the most skilful disinterested bystanders, and their decision must be considered as conclusive.

Remarks.—There are a few points respecting these laws which call for notice. It will be seen that in actual play the chessmen are not to be touched except to be played, unless for the purpose of re-adjusting a man on his proper square, when you must signify your intention by saying *J'adoube*, or "I adjust." The laws which regulate what is called the *strict* game, are of great importance to be attended to; for it is impossible to become a chess-player except by playing slowly and never taking back a move. We have some faith in the "morals of chess," and believe, that when properly played, the game exercises caution, forethought, and perseverance; but all these qualities are lost sight of if a player be allowed to pull about the pieces mechanically, instead of mentally calculating his move, and making it when he has decided on it. There are many drawing-room players who object to take odds of a superior player, but nevertheless do not hesitate to take back moves, not considering that this is odds, and very large odds too. We often meet with players who look with mild astonishment when you take a pawn *en passant*, or queen a pawn when you have already a queen on the board; or castle when your rook is under attack; or when you declare the game to be drawn by a stale-mate, or by your adversary's persisting in playing when there is not sufficient mating-force on the board, &c. A few remarks on these points may be useful. With respect to pawn takes pawn, *en passant*, an example of the practice by one of our great chess-authorities will be decisive. The following short game is a good example of Mr. Cochrane's brilliant

* Staunton has *last*.

style of attack, and it will be seen that the game is won off-hand, or *forced* as it is called, in consequence of the privilege in question:—

White, Mr. C.	Black.
1. P. to K. 4.	1. P. to K. 4.
2. K. Kt. to K. B. 3.	2. Q. Kt. to Q. B. 3.
3. K. B. to Q. B. 4.	3. K. B. to Q. B. 4.
4. P. to Q. B. 3.	4. K. Kt. to K. B. 3.
5. P. to Q. 4.	5. P. takes P.
6. P. to K. 5.	6. K. Kt. to K. 5.
7. K. B. to Q. 5.	7. K. Kt. takes K. B. P.
8. K. B. takes K. B. P. (ch.)	8. K. takes B.
9. K. Kt. to Kt. 5, (ch.)	9. K. to Kt.
10. Q. to Q. Kt. 3, (ch.)	10. P. to Q. 4.
11. K. P. takes Q. P. *en passant*. (ch.)	11. Q. B. to K. 3.
12. Q. takes B. (ch.)	12. K. to B.
13. Q. mates.	

With respect to two queens, three bishops, &c. on the board at the same time, a notion prevails that when a pawn arrives at its eighth square, you can only claim in exchange for it, one of the pieces you have lost. In the following position by Kling (*Diagram* 4), White has a

Diagram 4.

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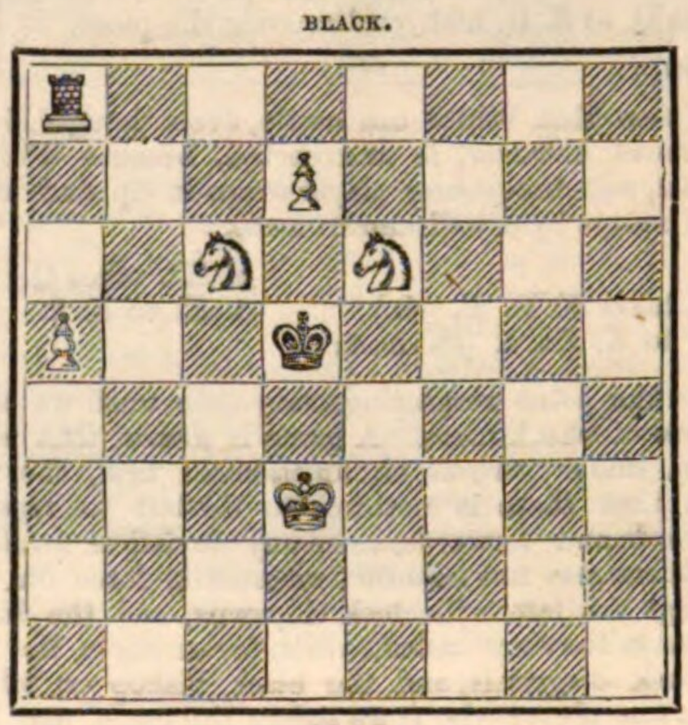

WHITE.

pawn at his Q. seventh. Now it is curious that, supposing White to have the move, he can mate in a fewer number of moves by queening the pawn and exchanging it for a knight than by exchanging it for a queen. Having made this move, he thus has three knights on the board which mutually protect each other. Black has now to play, and he has but one move, namely K. to Q. third, whereupon you play R. to Q. R. seventh. Black's only move is K. to Q. fourth, and you mate next move with the rook. In the next position (*Diagram* 5), also by

Diagram 5.

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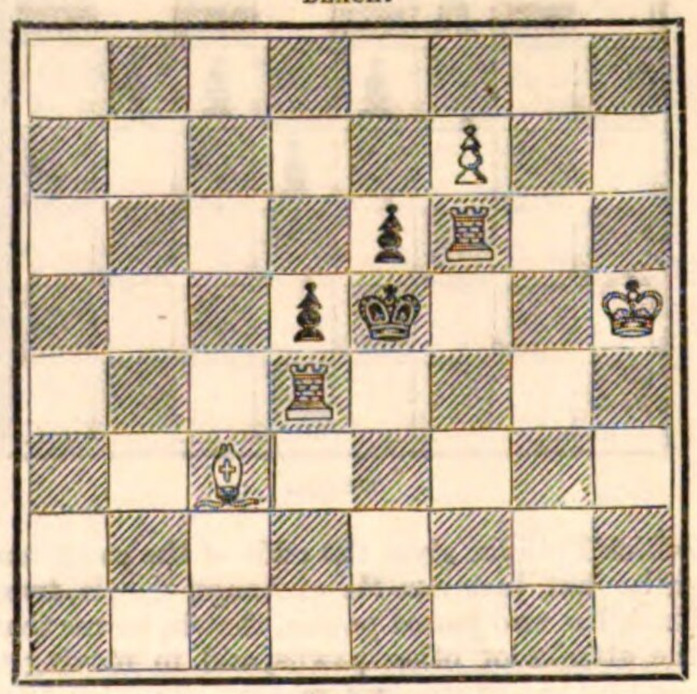

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Kling, if you queen the pawn and exchange it for a queen, you stale-mate your adversary, for he has no move except to place himself in check, which by the laws of the game he is not allowed to do; but if in queening your pawn you claim a bishop, you can check-mate him next move. Now it does seem a great anomaly that you can have a very different force, different not only in amount but in kind, at the end of the game to what you have at the beginning, such as three knights, or as in the present case two bishops, both running on black

diagonals. The very expression too, *queening a pawn*, is ambiguous; for the term is still made to apply, even though you exchange the pawn for a rook or a *minor piece*, as the bishop or the knight is called.

With respect to castling, Law xvi. defines the conditions under which that privilege can be exercised. Many players suppose that you cannot castle if the king has been checked, or if the rook is attacked. Now although it is quite true that you cannot castle out of check, it does not matter how many times your king may have been checked, provided he has not been moved. So also, with respect to the rook, you cannot castle if it has been moved, but you can castle, even though it be *en prise*, as in the following brilliant little game, in which Captain Kennedy gives the odds of his king's knight to the player of the black pieces; so that in setting up the board for this game you will remember to take off the white K. Kt.

WHITE, Capt. K.	BLACK.
1. P. to K. 4.	1. P. to K. 4.
2. K. B. to Q. B. 4,	2. K. Kt. to K. B. 3.
3. P. to Q. 4.	3. Kt. takes K. P.

Black at his third move should have played Pawn takes Pawn.

4. Q. P. takes P.	4. Kt. K. B. P.

Black intends the white king to take his Kt., whereupon he would check with his Q. at K. R. fifth, and recover the piece.

5. Castles.

It will be seen that White can castle, even though his rook be *en prise*. The move, however, is unexpected, because White leaves his queen *en prise*, and the young player snaps it up and loses the game in a couple of moves by a well known mate.

	5. Kt. takes Q.
6. K. B. takes K. B. P. (ch.)	6. K. to K. 2.
7. Q. B. to K. Kt. 5. (ch.-mate.)	

We reserve the point respecting stale-mate until we come to speak of the varieties of check-mate. A game is *drawn*, that is, not won by either player, under various circumstances: first, the position may be so locked that there is nothing to do but to repeat the same moves backwards and forwards, since any deviation would entail loss: or secondly, there may not be sufficient mating force on the board, as when the kings are left with locked pawns, and the bishops are of *opposite colours* as they are called, when, for example, the white bishop moves on black diagonals, and the black bishop on white ones; or thirdly, when one player who fears to lose the game, may have it in his power to check the king every move, and should he persist in doing so, he draws the game by what is called a *perpetual check*. The following is an example of this kind (*Diagram* 6), in a game between Philidor and

Diagram 6.

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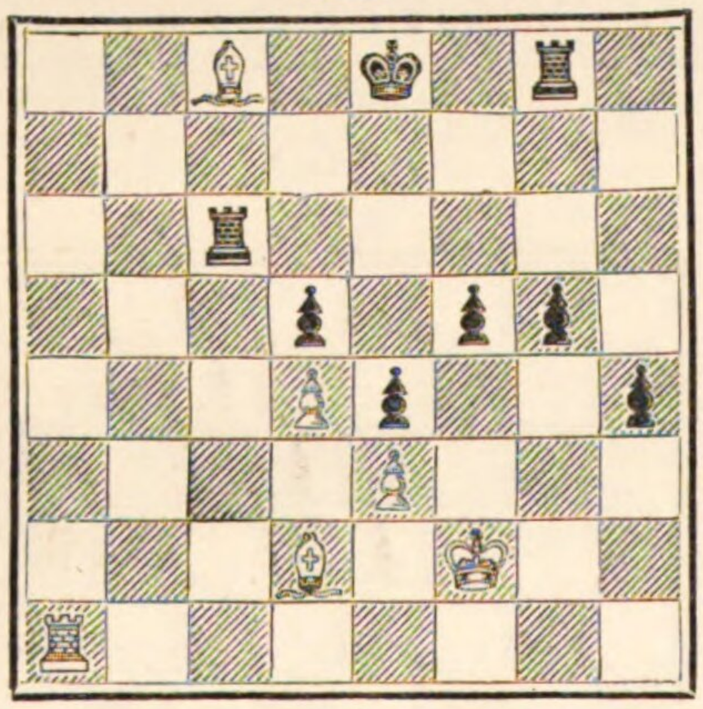

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Bowdler, in which Philidor gives the odds of the pawn and two moves; and although he has just *won the exchange*, that is, two minor pieces for a rook, Black has two *passed* pawns, that is, pawns that have *passed*, or escaped the attacks of other pawns, and in moving to queen, can only be opposed by the adversary's pieces. Philidor, therefore, having the move, seeks to break up this formidable array of pawns, by first capturing the black K. B. P. with his K. B., whereupon Black *pins* the bishop by playing R. to K. B. 3., and White now seizes the opportunity of drawing the game by a perpetual check. He plays R. to Q. R. eighth, checking; black king goes to king's bishop seventh; white checks again at Q. R. seventh; king moves to K. B. square; rook checks again, and king goes to K. Kt. second square: White checks again, and K. goes back to B. square, and both parties persisting in this line of play, the game is drawn; for should White seek to

escape the check by playing to K. R.'s square, he would be mated on the move. The following is another perpetual, also from Philidor

Diagram 7.

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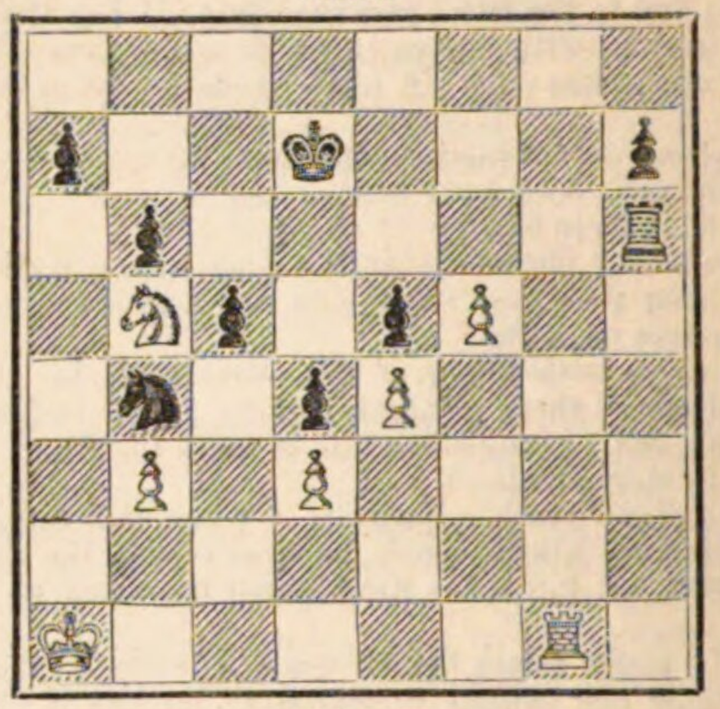

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(*Diagram* 7), in which that great master has again the worst of the game, Black having a passed pawn, and threatening to take off the Q. P. with his Kt., and thus have another passed pawn. Instead of defending his Q. P. with his R., he plays R. to Kt. seventh, checking, whereupon Black inconsiderately plays his K. to Q. B. third, White takes Q. R. P. with his Kt., checking. King has only one square to move to, namely, Q. third, whereupon Kt. checks again and so on perpetually.

Check-mate.—The object of the game of chess is to check-mate your adversary in the fewest possible number of moves. It would be considered bad play in any given position of the pieces with a mate on the board, to finish the game in four moves when it could be accomplished in three. The average length of a game is about thirty moves on each side; but we have known a game extend to ninety or a hundred moves on each side. With very bad play on the part of your adversary, mate may be given in two moves: this is known as the "Fool's Mate," and is as follows:—

WHITE.	BLACK.
1. P. to K. B. 4.	1. P. to K. 3.
2. P. to K. Kt. 4.	2. Q. to K. R. 5, Check-mating.

This is the shortest possible game of chess. The next shortest game is known as the "Scholar's Mate." It is as follows:—

WHITE.	BLACK.
1. P. to K. 4.	1. P. to K. 4.
2. K. B. to Q. B. 4.	2. K. B. to Q. B. 4.
3. Q. to K. R. 5.	3. P. to Q. 3.
4. Q. takes K. B. P., check-mating.	

There is a peculiar kind of mate given by the knight, known as the "Smothered Mate;" it is also sometimes called "Philidor's Legacy," from a position left by that great master. The following (*Diagram* 8)

Diagram 8.

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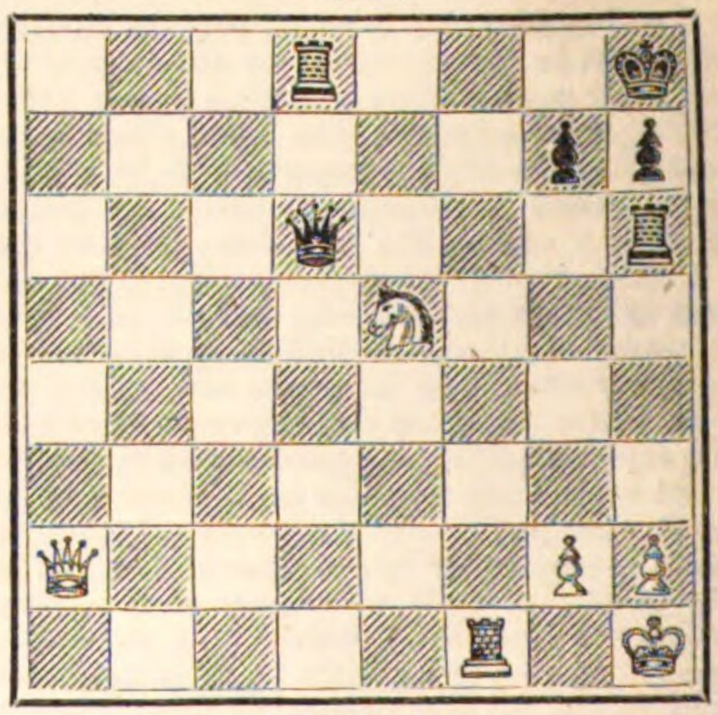

WHITE.

will illustrate it, together with the peculiar powers of the knight in attacking a number of pieces at the same time. Supposing White to have the move, he plays knight to K. B. seventh, checking, and at the

same time *forking*, as it is called king, queen, and two rooks. The black king can only get out of check by moving to Kt. square, whereupon the knight takes rook at K. R. third with a *double check*, for he not only checks with the knight, but discovers check with the queen. There is but one method of escaping from a double check, and that is by moving the king. In the present case the king cannot move to his K. B. square, on account of the position of your rook at K. B. square; he must therefore go back into the corner, whereupon you play your queen to K. Kt. eighth, checking; Black must take your queen with his rook, whereupon knight goes to K. B. seventh, giving a smothered mate.

Stale-mate.—Another description of mate is the "Stale Mate." It occurs when the king, not being in check, cannot move without moving into check, and has no other piece or pawn which can be moved. This

Diagram 9.

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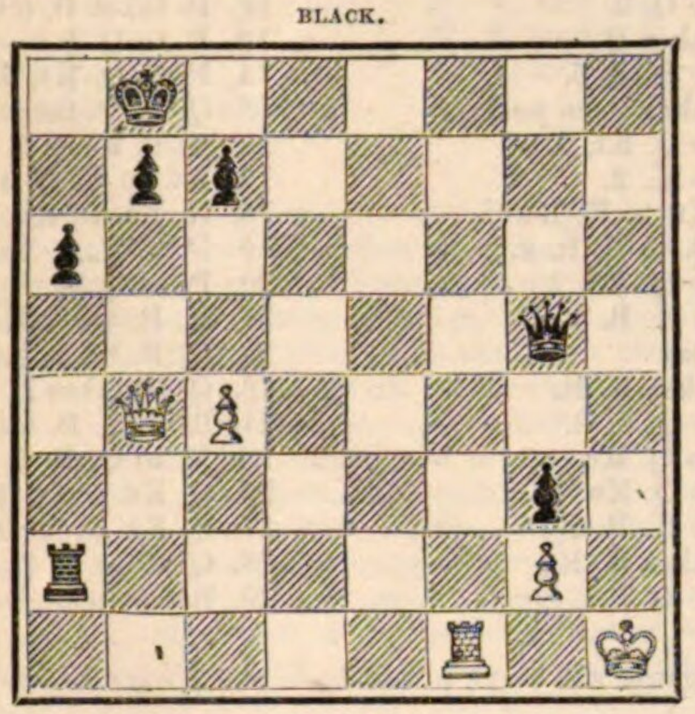

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makes what is called a drawn game, neither party winning. There are, as already remarked, several modes of drawing the game, and this is one of them. A skilful player, whose game appears to be hopelessly lost, will sometimes try after a stale, and cleverly effect his object to the great annoyance of his adversary. The above position (*Diagram* 9), given by Sarratt, is a case in point. In this position it seems impossible for White to save the game, since Black threatens to check with the queen and to mate at K. R. seventh; but it is a matter of great importance at chess who has *the move*. In the present case White has the move, and he plays as follows :—

White.	Black.
1. R. to K. B. 8 (ch.)	1. K. to Q. R. 2.
2. R. to Q. R. 8 (ch.)	2. K. takes R.
3. Q. to K. B. 8 (ch.)	3. K. to Q. R. 2.
4. Q. to Q. B. 5 (ch.)	

If Black move his king back to Q. R. square, you again check with your queen at K. B. eighth, and draw the game by a perpetual check. If he interpose queen's knight's pawn you capture his queen's bishop's pawn, and again draw by a perpetual check. You cannot, of course, capture his queen, on account of the threatened mate with his rook. If he capture your queen you are stale mated, because the king not being in check, cannot move without moving into check.

There is another solution to this problem, by which the moves of the Black are so far forced, that he loses the game unless he consent to draw by stale mate.

White.	Black.
1. R. to K. B. 8 (ch.)	1. K. to Q. R. 2.
2. Q. to Q. B. 5 (ch.)	2. Q. takes Q.
3. R. to Q. R. 8 (ch.)	3 K. to Q. Kt. 3.
4. R. takes Q. R. P. (ch.)	4. K. or P. takes R.
5. is stale mated.	

If at the third move Black take rook, White is stale-mated in a fewer number of moves.

According to the laws of the game, a stale-mate is a drawn game. It is also optional whether a player take a pawn *en passant* or not. A curious point was discussed by some members of the laws' committee, already referred to, as to whether in order to escape a stale-mate, a player could be compelled to take a pawn *en passant*. For example, in the following position (*Diagram* 10), suppose White to play pawn to K. Kt. fourth square, Black would be stale-mated unless he took the pawn *en passant*. It was contended that you could not compel an act which was purely voluntary, since it is expressly provided that while a player may advance his pawn two steps at the first move, it is optional whether the second player allow the *passar bataglia*, as the Italians call it, and that it would be contrary to the principles of chess to determine otherwise. On the other hand, it was contended by Mr. Tomlinson that so long as the stale-mate is defined to be "a position in which the

king, not being in check, cannot move without passing into check, and there is no other possible move on the board," the voluntary nature of the *passar bataglia* becomes changed into a *compulsory*, because a *possible* move. In such a position as the following (*Diagram* 10), it

Diagram 10.

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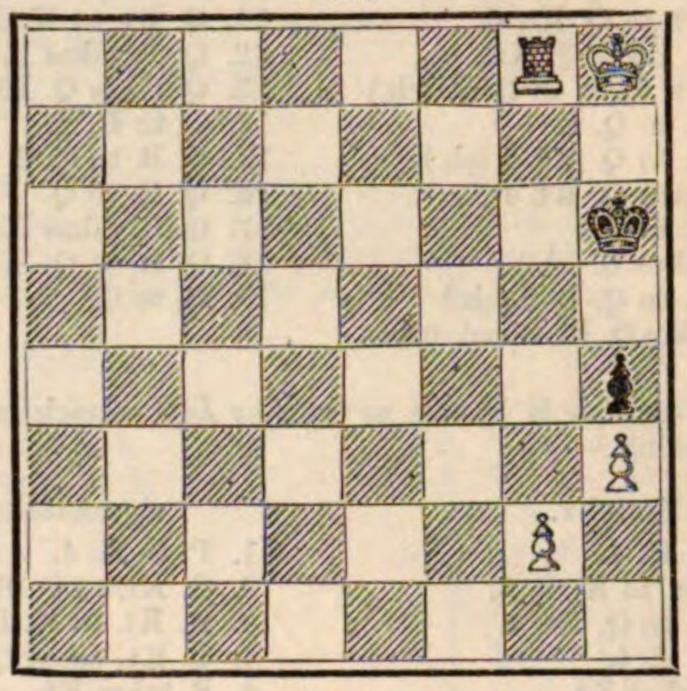

WHITE.

would be very anomalous if Black were to be allowed a stale-mate when he has it in his power to move one of his pawns.

The Openings.—The various modes of opening the game are: 1. *The King's Knight's game;* 2. *The King's Bishop's game;* 3. *The Queen's Bishop's Pawn's game;* 4. *The King's Gambit;* 5. *The Queen's Gambit.* Each of these openings has a number of varieties, many of which have also their distinctive names. Most of them are known as *regular* openings, to distinguish them from a rather large class which may be collected together into, 6. *Miscellaneous* or *irregular* openings. Games in any opening are called *open*, when each player plays at his first move Pawn to K. fourth square; whereas those games are called *close*, in which one or both of the players play at his first move Pawn to K. third square; or the second player, in answer to Pawn to K. fourth square, moves his queen's bishop's pawn to his fourth square, forming what is called the *Sicilian Game.*

We will give a few games illustrative of the openings, and their principal varieties. Our examples will consist of actual games by first-rate players. We shall not trouble the reader with many explanatory notes, as he will be able in most cases by careful study to discover for himself the beauties and peculiarities of each master.

The following is an example of that variety of the King's Knight's game, called by the Italian masters the *Giuoco Piano*, a term which we have adopted; games of this kind being also called *Piano* games. We do not indicate the colours, since it is desirable to be able to play either with the white pieces or with the black. If the student is accustomed to play only with white men, he will do well to take the black pieces in playing over these games.

Popert.	Cochrane.
1. P. to K. 4.	1. P. to K. 4.
2. K. Kt. to K. B. 3.	2. Q. Kt. to Q. B. 3.
3. K. B. to Q. B. 4.	3. K. B. to Q. B. 4.
4. P. to Q. B. 3.	4. Q. to K. 2.
5. Castles.	5. P. to Q. 3.
6. P. to Q. 4.	6. K. B. to Q. Kt. 3.
7. Q. B. to K. 3.	7. K. Kt. to K. B. 3.
8. Q. Kt. to Q. 2.	8. Q. B. to K. Kt. 5.
9. P. to Q. 5.	9. Q. Kt. to Q.
10. B. takes B.	10. Q. R. P. takes B.
11. Q. to Q. B. 2.	11. K. Kt. to K. R. 4.
12. P. to K. R. 3.	12. Q. B. to Q. 2.
13. K. to K. R. 2.	13. Castles.
14. Kt. to K. Kt.	14. P. to K. B. 4.
15. Q. to Q.	15. Q. to K. B. 2.
16. K. P. takes K. B. P.	16. Q. takes P.
17. P. to K. Kt. 4.	17. Q. takes K. B. P. (ch.)
18. R. takes Q.	18. R. takes R. (ch.)
19. K. to R.	19. Kt. check-mates.

The following is a variety of King's Knight's opening, known as the *Scotch opening*, from the circumstance of its having been adopted in the match by correspondence between the clubs of London and Edinburgh; it is also known as the *Queen's Pawn two* opening, and the *Central Gambit*. The opening is however to be found in Lolli.

Bilguer.	——
1. P. to K. 4.	1. P. to K. 4.
2. K. Kt. to K. B. 3.	2. Q. Kt. to Q. B. 3.
3. P. to Q. 4.	3. P. takes P.
4. K. B. to Q. B. 4.	4. K. B. to Q. Kt. 5 (ch.)

Bilguer.	
5. P. to Q. B. 3.	5. P. takes P.
6. Castles.	6. P. takes Q. Kt. P.
7. Q. B. takes P.	7. K. B. to K. B.
8. Q. to Q. 5.	8. K. Kt. to K. R. 3.
9. K. Kt. to K. Kt. 5.	9. Q. to K. 2.
10. Q. Kt. to Q. B. 3.	10. P. to Q. 3.
11. Q. Kt. to Q. Kt. 5.	11. Q. Kt. to K. 4.
12. Q. B. takes Q. Kt.	12. Q. P. takes B.
13. Q. Kt. takes Q. B. P. (ch.)	13. Q. takes Q. Kt.
14. Q. R. to Q. B.	14. Q. to K. 2.
15. K. B. to Q. Kt. 5 (ch.)	15. Q. B. to Q. 2.
16. Q. takes Q. Kt. P.	16. Q. R. to Q.
17. K. R. to Q.	17. Q. B. takes B.
18. Q. takes B. (ch.)	18. Q. R. to Q. 2.
19. Q. R. to Q. B. 8 (ch.)	19. Q. to Q.
20. Q. takes Q. R., Check-mate.	

The next example is known as the *Ruy Lopez* attack in the King's Knight's opening :—

Morphy.	Anderssen.
1. P. to K. 4.	1. P. to K. 4.
2. K. Kt. to K. B. 3.	2. Q. Kt. to Q. B. 3.
3. K. B. to Q. Kt. 5.	3. K. Kt. to K. B. 3.
4. P. to Q. 4.	4. Q. Kt. takes Q. P.
5. Kt. takes Kt.	4. P. takes Kt.
6. P. to K. 5.	6. P. to Q. B. 3.
7. Castles.	7. P. takes B.
8. Q. B. to K. Kt. 5.	8. K. B. to K. 2.
9. P. takes Kt.	9. B. takes P.
10. R. to K. (ch.)	10. K. to B.
11. B. takes B.	11. Q. takes B.
12. P. to Q. B. 3.	12. P. to Q. 4.
13. P. takes P.	13. B. to K. 3.
14. Q. Kt. to Q. B. 3.	14. P. to Q. R. 4.
15. R. to K. 5.	15. Q. R. to Q.
16. Q. to Q. Kt. 3.	16. Q. to K. 2.
17. Q. R. to K.	17. P. to K. Kt. 4.
18. Q. to Q.	18. Q. to K. B. 3.
19. Q. R. to K. 3.	19. K. R. to K. Kt.
20. R. takes B.	20. P. takes R.
21. R. to K. B. 3.	21. Resigns.

The following variety of the Knight's opening is known as the *Evans' Gambit*, from the name of the inventor, Captain Evans, R.N. It consists in the sacrifice of the queen's knight's pawn at the fourth move of the first player, thereby enabling him to establish his pawns in the centre, and to attack the adversary's king with his queen and queen's bishop. We may here remark that the word *gambit* is from the Italian *giambetto*, a term used in wrestling where by a peculiar turn of the leg the adversary is overthrown. There are many forms of gambit at chess, and in every one there is the sacrifice of a pawn early in the game; this being the trick by which a powerful attack is gained. In the following game the Indian chess player, Shagird, gives the odds of the queen's knight, so that in setting up the pieces be careful to remove the first player's queen's knight.

Shagird.	
1. P. to K. 4.	1. P. to K. 4.
2. Kt. to K. B. 3.	2. Kt. to Q. B. 3.
3. B. to Q. B. 4.	3. B. to Q. B. 4.
4. P. to Q. Kt. 4.	4. B. takes Q. Kt. P.
5. P. to Q. B. 3.	5. B. to Q. R. 4.
6. Castles.	6. Kt. to K. B. 3.
7. Q. to Q. B. 2.	7. P. to Q. 3.
8. P. to K. R. 3.	8. Castles.
9. P. to Q. 4.	9. P. takes P.
10. P. takes P.	10. B. to Q. Kt. 3.
11. R. to Q.	11. Q. Kt. to R. 4.
12. Q. B. to Q. 3.	12. Q. B. to Q. 2.
13. P. to K. 5.	13. P. takes P.
14. P. takes P.	14. K. Kt. to K.
15. K. B. takes K. R. P. (ch.)	15. K. to R.

If he capture the bishop, he either loses his queen, or is mated in two moves.

16. Q. B. to Q. R. 3.	16. P. to Q. B. 4.
17. B. takes P.	17. B. takes B.
18. Q. takes B.	18. K. Kt. to Q. B. 2.
19. K. B. to B. 5.	19. P. to Q. Kt. 3.
20. Q. to Q. Kt. 4.	20. K. Kt. to K. 3.
21. R. takes B.	21. Q. takes R.
22. Q. to K. R. 4 (ch.)	22. K. to Kt.
23. Q. mates.	

The next game is know as *Philidor's defence* in the Knight's opening. It consists in defending the King's pawn by means of the Queen's pawn.

Although it shuts in the King's Bishop for a time, it is a good and sound defence.

	Philidor.
1. P. to K. 4.	1. P. to K. 4.
2. Kt. to K. B. 3.	2. P. to Q. 3.
3. P. to Q. 4.	3. P. to K. B. 4.
4. P. takes K. P.	4. K. B. P. takes K. P.
5. Kt. to Kt. 5.	5. P. to Q. 4.
6. P. to K. B. 4 (P. to K. 6, better).	6. K. B. to Q. B. 4.
7. P. to Q. B. 4.	7. P. to Q. B, 3.
8. Q. Kt. to B. 3.	8. K. Kt. to K. 2.
9. P. to K. R. 4.	9. P. to K. R. 3.
10. K. Kt. to R. 3.	10. Castles.
11. Q. Kt. to Q. R. 4.	11. B. to Q. Kt. 5 (ch.)
12. B. to Q. 2.	12. B. takes B. (ch.)
13. Q. takes B.	13. P. to Q. 5.
14. P. to Q. B. 5.	14. P. to Q. Kt. 4.
15. P. takes P. *en passant.*	15. Q. R. P. takes P.
16. P. to Q. Kt. 3.	16. Q. B. to K. 3.
17. B. to K. 2.	17. Kt. to K. B. 4.
18. K. Kt. to K. Kt.	18. K. Kt. to Kt. 6.
19. K. R. to K. R. 2.	19. P. to K. 6.
20. Q. to Q. Kt. 2.	20. P. to Q. 6.
21. B. to K. B. 3.	21. K. R. takes K. B. P.
22. Castles.	22. K. R. takes Kt.
23. P. takes K. R.	23. Q. R. takes P.
24. P. to Q. R. 3.	24. R. to Q. B. 5 (ch.)
25. K. to Q. Kt.	25. R. to Q. B. 7.
26. Q. to Q. Kt. 4.	26. Q. Kt. to Q. R. 3.
27. Q. to K. B. 4.	27. Q. Kt. to Q. B. 4.
28. Q. takes K. Kt.	28. Q. B. to R. 7 (ch.)
29. K. to Q. R.	29. Kt. mates.

The next game will serve to illustrate the *King's Bishop's* opening.

Cochrane.	Staunton.
1. P. to K. 4.	1. P. to K. 4.
2. K. B. to Q. B. 4.	2. K. B. to Q. B. 4.
3. P. to Q. 4.	3. B. takes P.
4. Kt. to K. B. 3.	4. Kt. to Q. B. 3.
5. Castles.	5. Kt. to K. B. 3.
6. Kt. takes B.	6. Kt. takes Kt.
7. P. to K. B. 4.	7. P. to Q. 3.
8. P. takes P.	8. P. takes P.
9. Q. B. to K. Kt. 5.	9. Q. B. to K. 3.
10. B. takes B.	10. Kt. takes B.
11. Q. takes Q. (ch.)	11. Q. R. takes Q.
12. B. takes Kt.	12. K. Kt. P. takes B.
13. R. takes P.	13. Kt. to K. B. 5.
14. Kt. to Q. B. 3.	14. R. to Q. 7.
15. Q. R. to Q.	15. R. takes K. Kt. P. (ch.)
16. K. to R.	16. K. R. to K. Kt.
17. K. R. to K. B. 5.	17. P. to K. B. 3.
18. R. takes K. B. P.	18. Kt. to K. R. 6.
19. K. R. to K. B.	19. R. to Kt. 8 (ch.)
20. R. takes R.	20. Kt. mates.

The following game from Greco is a variety of the King's Bishop's opening known as the *Lopez Gambit* :—

1. P. to K. 4.	1. P. to K. 4.
2. K. B. to Q. B. 4.	2. K. B. to Q. B. 4.
3. Q. to K. 2.	3. Q. to K. 2.
4. P. to K. B. 4.	4. K. B. takes K. Kt.

In this gambit it is not advisable to capture the pawn thus offered.

5. K. R. takes B.	5. K. P. takes P.
6. P. to Q. 4.	6. Q. to K. R. 5 (ch.)
7. P. to K. Kt. 3.	7. P. takes P.
8. K. R. takes P.	8. K. Kt. to K. B. 3.
9. Q. Kt. to Q. B. 3.	9. K. Kt. to K. R. 4.
10. K. B. takes K. B. P. (ch.)	10. K. takes B.
11. Q. B. to K. Kt. 5.	11. Kt. takes R.
12. Q. to K. B. 3 (ch.)	12. K. to Kt. 3.
13. Q. B. takes Q.	13. K. Kt. to K. R. 4.
14. Q. to K. B. 5 (ch.)	14. K. to K. R. 3.
15. Q. mates.	

The following is an example of the *Queen's Bishop's Pawn's* opening :—

Capt. Evans.	M. St. Amant.
1. P. to K. 4.	1. P. to K. 4.
2. P. to Q. B. 3.	2. P. to Q. B. 4 (P. to Q. 4, best).
3. Kt. to K. B. 3.	3. Kt. to Q. B. 3.
4. K. B. to Q. B. 4.	4. Kt. to K. B. 3.
5. P. to Q. 4.	5. Q. B. P. takes P.

Capt. Evans.	M. St. Amant.
6. K. Kt. to Kt. 5.	6. P. to Q. 4.
7. P. takes P.	7. K. Kt. takes P.
8. K. Kt. takes K. B. P.	8. K. takes Kt.
9. Q. to K. B. 3. (ch.)	9. K. to K. 3.
10. Castles.	10. Q. Kt. to R. 4.
11. Q. B. to Q. Kt. 5.	11. Q. to Q. 3.
12. P. to K. Kt. 4.	12. Q. to Q. 2.
13. K. B. to Q. 3.	13. Q. to K. B. 2.
14. B. to K. B. 5 (ch.)	14. K. to Q. 3.
15. P. takes Q. P.	15. Q. B. takes B.
16. P. takes P. (ch.)	16. K. takes P.
17. P. takes B.	17. Q. Kt. to B. 3.
18. K. R. to K. (ch.)	18. K. to Q. 3.
19. R. to K. 6 (ch.)	19. K. to Q. B. 4.
20. Q. B. to K. 3 (ch.)	20. K. Kt. takes B.
21. Q. takes K. Kt. (ch.)	21. K. to Kt. 4.
22. Q. to Q. 3 (ch.)	22. K. to Kt. 3.
23. Q. to Q. Kt. 3 (ch.)	23. K. to B. 2.
24. R. takes Kt. (ch.), winning Q. and the game.	

We now come to the regular gambits which produce some of the most brilliant and complicated positions in chess. In the *King's Gambit* the first player sacrifices his king's bishop's pawn at the second move, for the sake of a good attacking position. The second player may safely capture the profferred pawn with his king's pawn, and defend the *gambit pawn* * against any attack. This extra pawn ought, with good play, eventually to lead to a won, or at least a drawn, game; but the variety of attack, and the difficulty of correct defence are so great, that even among the best players the gambit is frequently adopted. Although so much has been written on the subject by chess analysts, yet new forms of attack and defence appear every year, so inexhaustible is the variety afforded by the royal game. The following is an example of the *King's Knight's Gambit*, in which the king's knight is brought out at the third move, to distinguish it from the *King's Bishop's Gambit*, in which the king's bishop is so played. Another variety of the king's gambit is the *King's Rook's Pawn's Gambit*, in which the king's rook's pawn is played at the third move. There is also the *Muzio Gambit*, the *Allgaier gambit*, the *Cunningham gambit*, &c. Our first example is of the King's Knight's Gambit between two celebrated players :—

Von der Laza.	Dr. Bledow.
1. P. to K. 4.	1. P. to K. 4.
2. P. to K. B. 4.	2. P. takes P.
3. Kt. to K. B. 3.	3. P. to K. Kt. 4.
4. K. B. to Q. B. 4.	4. K. B. to K. Kt. 2.
5. P. to Q. 4.	5. Q. to K. 2 (P. to Q. 3, better).
6. Castles.	6. P. to K. R. 3.
7. Q. Kt. to B. 3.	7. P. to Q. B. 3.
8. P. to K. 5.	8. Q. to Q. Kt. 5.
9. Q. Kt. to K. 4.	9. K. B. home.

Because, had Q. captured the B., you could have forked K. and Q. with Kt.

10. Q. to K. 2.	10. P. to K. Kt. 5.
11. Kt. to Q. 6 (ch.)	11. B. takes Kt.
12. P. takes B. (disc. ch.)	12. K. to Q.
13. Kt. to K. 5.	13. R. to R. 2.
14. P. to Q. B. 3.	14. P. to K. B. 6.
15. Q. to K. 4.	15. K. Kt. to B. 3.
16. Q. takes R.	16. Kt. takes Q.

The first player now commenced a forced mate in six moves, namely, 17. Kt. takes P. (ch.); 18. R. to K. (ch.); 19. Q. B. takes P. (ch.); 20. R. to K. 8 (ch.); 21. R. takes Kt. (ch.); 22. K. B. to Q. 3, mate. The moves of the black K. are all forced.

The following variety of the King's Gambit is known as the *Muzio gambit*. In it the second player, at his fourth move, pushes the pawn on his adversary's king's knight, which is allowed to be captured for the sake of the attack which is thus gained :—

M'Donnell.	De la Bourdonnais.
1. P. to K. 4.	1. P. to K. 4.
2. P. to K. B. 4.	2. P. takes P.
3. K. Kt. to K. B. 3.	3. P. to K. Kt. 4.
4. B. to Q. B. 4.	4. P. to K. Kt. 5.
5. Q. Kt. to Q. B. 3.	5. P. takes Kt.
6. Q. takes P.	6. K. B. to K. R. 3.
7. P. to Q. 4.	7. Kt. to Q. B. 3.
8. Castles.	8. Kt. takes Q. P.
9. B. takes K. B. P. (ch.)	9. K. takes B.
10. Q. to K. R. 5 (ch.)	10. K. to Kt. 2.

* The term *Gambit pawn* is first applied to the pawn which is sacrificed by the first player, and then to the pawn which captures it, and is defended by the second player.

M'Donnell.	De la Bourdonnais.
11. B. takes the gambit P.	11. B. takes B.
12. R. takes B.	12. K. Kt. to B. 3.
13. Q. to K. Kt. 5 (ch.)	13. K. to B. 2.
14. Q. R. to K. B.	14. K. to K.
15. R. takes Kt.	15. Q. to K. 2.
16. Kt. to Q. 5.	16. Q. to Q. B. 4.
17. K. to R.	17. Kt. to K. 3.
18. R. takes Kt. (ch.)	18. P. takes R.
19. Kt. to K. B. 6, checking and winning Q.	19. Resigns.

The following is one of the many forms of the *Allgaier gambit*. The first player moves pawn to K. R. 4, at the fourth move, and the second player pushes his pawn on the knight which is not left to be captured as in the *Muzio*, but is played to K. 5, or K. Kt. 5 :—

Morphy.	Medley.
1. P. to K. 4.	1. P. to K. 4.
2. P to K. B. 4.	2. P. takes P.
3. Kt. to K. B. 3.	3. P. to K. Kt. 4.
4. P. to K. R. 4.	4. P. to K. Kt. 5.
5. Kt. to K. 5.	5. Kt. to K. B. 3.
6. B. to Q. B. 4.	6. P. to Q. 4.
7. P. takes P.	7. K. B. to Q. 3.
8. P. to Q. 4.	8. Kt. to K. R. 4.
9. Kt. to Q. B. 3.	9. Q. B. to K. B. 4.
10. Kt. to K. 2.	10. Q. to K. B. 3.
11. Q. Kt. takes P.	11. Kt. to Kt. 6.
12. Kt. to K. R. 5.	12. Kt. takes Kt.
13. B. to K. Kt. 5.	13. K. B. to Q. Kt. 5 (ch.)
14. P. to Q. B. 3.	14. Q. to Q. 3.
15. Castles.	15. K. Kt to Kt. 2.
16. R. takes Q. B.	16. Kt. takes R.
17. Q. takes K. Kt. P.	17. K. Kt. to K. 2.
18. R. to K.	18. P. to K. R. 4.
19. Q. to K. B. 3.	19. K. R. to R. 2.
20. K. B. checks.	20. P. to Q. B. 3.
21. P. takes P.	21. P. takes P.
22. Kt. takes Q. B. P.	22. Kt. takes Kt.
23. B. takes Kt. (ch.)	23. Resigns.

The following is a specimen of a *King's Bishop's Gambit* :—

M'Donnell.	De la Bourdonnais.
1. P. to K. 4.	1. P. to K. 4.
2. P. to K. B. 4.	2. P. takes P.
3. K. B. to Q. B. 4.	3. Q. to K. R. 5 (ch.)
4. K. to B.	4. P. to K. Kt. 4.
5. Kt. to Q. B. 3.	5. K. B. to Kt 2.
6. P. to Q. 4.	6. Kt. to Q. B. 3.
7. P. to K. 5.	7. K. Kt. to K. 2.
8. K. Kt. to B. 3.	8. Q. to K. R. 4.
9. Q. Kt. to K. 4.	9. P. to K. R. 3.
10. Kt. to K. B. 6 (ch.)	10. B. takes Kt.
11. P. takes B.	11. P. to Q. 4.
12. B. to Q. 3.	12. K. Kt. to B. 4.
13. Q. to K. (ch.)	13. K. to Q.
14. Kt. to K. 5.	14. K. Kt. takes Q. P.*
15. P. to Q. B. 3.	15. Q. Kt. takes Kt.
16. Q. takes Kt.	16. Kt. to Q. B. 3.
17. Q. takes Q. P. (ch.)	17. K. to K.
18. B. to Q. Kt. 5.	18. Q. B. to K. 3.
19. B. takes Kt. (ch.)	19. K. to K. B.
20. Q. to B. 5 (ch.)	20. K. to Kt.
21. B. to K. B. 3.	21. Q. to K. Kt. 3.
22. Q. to Q. 4.	22. P. to Q. B. 4.
23. Q. to K. 5.	23. Q. R. to K.
24. K. B. to K. 2.	24. P. to K. B. 6.
25. K. to B. 2.†	25. P. takes B.
26. Q. B. to K. 3.	26. P. to Q. Kt. 3.
27. P. to K. R. 4.	27. Q. B. to Q. 2.
28. Q. to Q. 5.	28. Q. takes P. (ch.)
29. K. takes P.	29. B. to K. Kt. 5 (ch.)
30. K. to Q. 2.	30. R. to Q.
31. Resigns.	

* If he check with Kt. and capture R., he is mated. For example :—

	14. Kt. to K. Kt. 6 (ch.)
15. K. to Kt. (best.)	15. Kt. takes R.
16. Kt. takes Kt. (ch.)	16. K. to Q. 2 (best).
17. Kt. to Q. Kt. 8 (ch.)	17. R. takes Kt.
18. K. B. to Q. Kt. 5 (ch.)	18. P. to Q. B. 3.
19. Q. to K. 7 (mate).	

† Capturing the P. would evidently cost him his Q.

Budzinsky.	Morphy.
1. P. to K. 4.	1. P. to K. 4.
2. P. to K. B. 4.	2. P. takes P.
3. K. B. to Q. B. 4.	3. P. to Q. 4.
4. K. B. takes P.	4. Kt. to K. B. 3.
5. Kt. to Q. B. 3.	5. B. to Q. Kt. 5.
6. P to Q. 3.	6. Kt. takes B.
7. P. takes Kt.	7. Castles.
8. Q. to K. B. 3.	8. R. to K. (ch.)
9. Kt. to K. 2.	9. B. takes Kt. (ch.)
10. P. takes B.	10. Q. to K. R. 5 (ch.)
11. P. to Kt. 3.	11. B. to K. Kt. 5, winning a piece.

As a general rule it is always best to accept the gambit when it is offered. The following little game from Greco is a specimen of what is called the *Gambit refused* :—

1. P. to K. 4.	1. P. to K. 4.
2. P. to K. B. 4.	2. P. to Q. 4.
3. K. P. takes Q. P.	3. Q. takes P.
4. Q. Kt. to Q. B. 3.	4. Q. to K. 3.
5. K. Kt. to K. B. 3.	5. P. takes P. (disc. check.)
6. K. to B. 2.	6. K. B. to Q. B. 4 (ch.)
7. P. to Q. 4.	7. K. B. to Q. 3.
8. K. B. to Q. Kt. 5 (ch.)	8. K. to Q.
9. K. R. to K.	9. Q. to K. B. 4.
10. K. R. to K. 8, checkmate.	

The *Queen's Gambit* is a very different opening from the king's. It is not so brilliant nor so varied, and the gambit pawn cannot be defended with safety. De la Bourdonnais was a master in this opening, and the following is a fine specimen of one of the games in his celebrated contest with M'Donnell :—

De la Bourdonnais.	M'Donnell.
1. P. to Q. 4.	1. P. to Q. 4.
2. P. to Q. B. 4.	2. P. takes P.
3. P. to K. 4.	3. P. to K. 4.
4. P. to Q 5.	4. P. to K. B. 4.
5. Q. Kt. to Q. B. 3.	5. K. Kt. to K. B. 3.
6. K. B. takes gambit P.	6. K. B. to Q. B. 4.
7. K. Kt. to B. 3.	7. Q. to K. 2.
8. Q. B. to K. Kt. 5.	8. K. B. takes K. B. P. (ch.)
9. K. to B.	9. K. B. to Q. Kt. 3.
10. Q. to K. 2.	10. P. to K. B. 5.
11. Q. R. to Q.	11. Q. B. to K. Kt. 5.
12. P. to Q. 6.	12. P. takes P.
13. Q. Kt. to Q. 5.	13. Kt. takes Kt.
14. B. takes Q.	14. Kt. to K. 6 (ch.)
15. K. to K.	15. K. takes B.
16. Q. to Q. 3.	16. K. R. to Q.
17. Q. R. to Q. 2.	17. Q. Kt. to B. 3.
18. P. to Q. Kt. 3.	18. K. B. to Q. R. 4.
19. P. to Q. R. 3.	19. Q. R. to Q. B.
20. K. R. to K. Kt.	20. P. to Q. Kt. 4.
21. K. B. takes P.	21. Q. B. takes Kt.
22. P. takes B.	22. Q. Kt. to Q. 5.
23. K. B. to Q. B. 4.	23. Kt. takes K. B. P. (ch.)
24. K. to B. 2.	24. Kt. takes Q. R.
25. R. takes K. Kt. P. (ch.)	25. K. to B. 3.
26. R. to K. B. 7 (ch.)	26. K. to Kt. 3.
27. R. to Q. Kt. 7.	27. Q. Kt. takes B.
28. P. takes Kt.	28. R. takes P.
29. Q. to Q. Kt.	29. B. to Q. Kt. 3.
30. K. to B. 3.	30. R. to Q. B. 6.
31. Q. to Q. R. 2.	31. Kt. to Q. B. 5 (disc. check).
32. K. to Kt. 4.	32. R. to K. Kt.
33. R. takes B.	33. P. takes R.
34. K. to R. 4.	34. K. to B. 3.
35. Q. to K. 2.	35. R. to K. Kt. 3.
36. Q. to K. R. 5.	36. Kt. to K. 6.
37. Resigns.	

The following specimen of a close game is known as the *Sicilian* opening :—

Cochrane.	Staunton.
1. P. to K. 4.	1. P. to Q. B. 4.
2. P. to Q. B. 4.	2. P. to K. 3.
3. Q. Kt. to B. 3.	3. K. Kt. to K. 2.
4. P. to K. B. 4.	4. K. Kt. to his 3rd.
5. P. to Q. 3.	5. K. B. to K. 2.
6. K. Kt. to B. 3.	6. P. to Q. 3.
7. K. B. to K. 2.	7. Q. Kt. to B. 3.
8. Castles.	8. K. B. to B. 3.
9. Q. B. to K. 3.	9. B. to Q. 5.
10. B. takes B.	10. P. takes B.

Cochrane.	Staunton.
11. Q. Kt. to his square.	11. K. Kt. takes P.
12. Q. to Q. 2.	12. P. to K. 4.
13. P. to Q. Kt. 4.	13. Q. Kt. takes P.
14. Q. takes Q. Kt.	14. Kt. takes B. (ch.)
15. K. to R.	15. Castles.
16. Q to Q. 2.	16. Kt. to K. B. 5.
17. Kt. takes Q. P.	17. Kt. takes Q. P.
18. Q. takes Kt.	18. P. takes Kt.
19. Q. takes P.	19. B. to K. 3.
20. Kt. to Q. B. 3.	20. Q. R. to Q. B.
21. Kt. to Q. 5.	21. P. to Q. Kt. 3.
22. K. R. to B. 3.	22. Q. R. to B. 4.
23. Q. R. to K. B.	23. B. takes Kt.
24. Q. B. P. takes B.	24. Q. to K. Kt. 4.
25. Q. to Q. R. 4.	25. Q. R. to B. 2.
26. Q. to Q. R. 3.	26. Q. to K. 4.
27. Q. to Q. 3.	27. K. R. to K.
28. K. R. to K. 3.	28. P. to K. B. 4.
29. P. to K. Kt. 3.	29. P. takes P.
30. Q. to Q. Kt. 5.	30. P. to K. R. 3.
31. Q. R. to K.	31. Q. R. to B. 4.
32. Q. to Q. 7.	32. Q. to K. 2.
33. Q. to K. B. 5.	33. Q. to K. B. 2.
34. Q. takes Q. (ch.)	34. K. takes Q.
35. K. R. to Q. R. 3.	35. K. R. to K. 2.
36. Q. R. to K. B. (ch.)	36. K. to Kt. 3, and wins.

The foregoing specimens will serve to illustrate something of the wonderful variety and beauty of chess. There are many other openings which in a longer article might be selected, together with games by Löwenthal, Horwitz, Harrwitz, Brien, and many other living players. We might also show the skill of first-rate men in giving the odds of rook, knight, or bishop; but as in such cases any of the regular openings may be played, it is the less necessary to do so, especially as we have already given one or two games at the odds of the knight. The odds of the pawn and move, or pawn and two moves, is however peculiar, and requires some illustration. When a strong player is unable to give his opponent a piece he gives him his best pawn, namely, the king's bishop's pawn, which at the commencement of an even game is defended by the king only, so that this is the weakest part of the board, and it is still further weakened by taking away the pawn. The difference between pawn and move, and pawn and two moves, is considerable; the two moves enabling the first player to take up a very strong position, and greatly to cramp his opponent's game.

The following is one of the games won by the Automaton Chess Player, when it was exhibited in London in 1820. The chief merit of this machine consisted in the skill with which a living player was concealed within it. The player was M. Mouret, an accomplished master of his day, as was proved by the fact, that he gave the odds of the pawn and move to all comers, so that in setting up the men the reader will remove the K. B. P. from the Automaton's side of the board.

Mr. Tolfrey.	The Automaton.
1. P. to K. 4.	1. P. to K. 3.
2. P. to Q. 4.	2. P. to Q. B. 3.
3. Q. B. to K. 3.	3. P. to Q. 4.
4. P. to K. 5.	4. P. to Q. Kt. 3.
5. P. to Q. R. 3.	5. P. to Q. B. 4.
6. P. to Q. B. 4.	6. Q. Kt. to Q. B. 3.
7. Q. B. P. takes P.	7. K. P. takes P.
8. Q. Kt. to Q. B. 3.	8. Q. B. to K. 3.
9. K. Kt. to K. B. 3.	9. K. B. to K. 2.
10. K. B. to Q. Kt. 5.	10. Q. to Q. 2.
11. Q. Kt. P. to Q. Kt. 4.	11. Q. B. P. takes Q. Kt. P.
12. Q. R. P. takes P.	12. K. B. takes P.
13. Q. B. to Q. 2.	13. K. Kt. to K. 2.
14. K. Kt. to K. Kt. 5.	14. K. B. takes Kt.
15. B. takes B.	15. Castles with K. R.
16. Castles.	16. P. to K. R. 3.
17. Kt to K. B. 3.	17. Q. B. to K. Kt. 5.
18. K. B. to K. 2.	18. P. to Q. R. 4.
19. P. to K. R. 3.	19. B. takes Kt.
20. B. takes B.	20. P. to Q. Kt. 4.
21. K. B. to K. Kt. 4.	21. K. Kt. to K. B. 4.
22. P. to K. Kt. 3.	22. P. to Q. Kt. 5.
23. Q. B. to Q. 2.	23. Q. to Q. R. 2.
24. B. takes Kt.	24. R. takes B.
25. B. takes K. R. P.	25. P. takes B.
26. Q. to K. Kt. 4 (ch.)	26. K. R. to K. Kt. 4.
27. Q. to K. 6 (ch.)	27. K. to R. 2.
28. Q. takes Kt.	28. P. to Q. R. 5.
29. Q. takes Q. P.	29. P. to Q. Kt. 6.
30. Q. R. to Q. R. 3.	30. Q. R. to Q. Kt.
31. K. R. to Q. Kt.	31. K. R. to K. Kt. 2.
32. Q. to K. 4 (ch.)	32. K. to R.
33. P. to Q. 5.	33. K. R. takes K. Kt. P. (ch.)

Mr. Tolfrey.	The Automaton.
34. K. to K. B.	34. Q. to Q. R. 3 (ch.)
35. Q. to K. 2.	35. K. R. to K. Kt. 8 (ch.)
36. K. takes R.	36. Q. takes Q.
37. P. to K. 6.	37. R. to K. Kt. (ch.)
38. K. to K. R.	38. Q. to K. B. 6 (ch.)
39. K. to K. R. 2.	39. Q. mates.

The following game at the same odds will show how a skilful player takes advantage of them. In setting up the men remove the K. B. P. from the second player's side of the board.

Mr. Buckle.	M. Kieseritzkij.
1. P. to K. 4.	1. Kt. to Q. B. 3.
2. P. to Q. 4.	2. P. to K. 4.
3. P. to Q. 5.	3. Q. Kt. to K. 2.
4. Q. B. to K. Kt. 5.	4. K. Kt. to K. B. 3.
5. B. takes Kt.	5. P. takes B.
6. Q. checks.	6. Kt. to K. Kt. 3.
7. K. Kt. to K. B. 3.	7. Q. to K. 2.
8. P. to Q. 6.	8. Q. to K. B. 2.
9. P. takes P.	9. K. B. to Q. B. 4.
10. Q. Kt. to Q. 2.	10. P. to Q. 3.
11. K. B. checks.	11. Q. B. to Q. 2.
12. Q. to K. B. 5.	12. K. R. to K. B.
13. Castles Q. R.	13. P. to Q. R. 3.
14. B. takes B. (ch.)	14. Q. takes B.
15. Q. Kt. to Q. B. 4.	15. Q. R. to Q. B.
16. Q. R. to Q. 5.	16. K. Kt. to K. 2.
17. Q. to K. R. 5 (ch.)	17. R. to K. B. 2.
18. Q. R. takes K. B.	18. P. takes R.
19. R. to Q.	19. Q. to K. 3.
20. Kt. to Q. 6 (ch.)	20. K. to B.
21. Kt. takes Q. R.	21. Kt. takes Kt.
22. Q. to R. 6 (ch.)	22. R. to Kt. 2.
23. R. to Q. 8 (ch.)	23. K. to B. 2.
24. Q. to R. 5 (ch.)	24. R. to Kt. 3.
25. Q. takes K. R. P. (ch.)	25. R. to Kt. 2.
26. Q. to R. 5 (ch.)	26. R. to Kt. 3.
27. R. takes Kt.	27. Q. takes R.
28. Kt. to K. R. 4.	28. Q. to K. Kt.
29. Q. takes R. (ch.)	29. Q. takes Q.
30. Kt. takes Q.	30. K. takes Kt.
31. P. queens and wins.	

The next two games are at the odds of the pawn and two moves, so that in each case the K. B. P., of the second player must be removed from the board.

Mr. ——	Mr. Staunton.
1. P. to K. 4.	1. ———
2. P. to Q. 4.	2. P. to K. 3.
3. K. B. to Q 3.	3. P. to Q. B. 4.
4. P. to Q. 5.	4. P. to Q. 3.
5. P. to Q. B. 4.	5. K. P. takes Q. P.
6. K. P. takes P.	6. K. Kt. to B. 3.
7. Q. Kt. to B. 3.	7. K. B. to K. 2.
8. K. Kt. to K. 2.	8. Castles.
9. Castles.	9. Q. Kt. to Q. 2.
10. P. to K. B. 4.	10. K. Kt. to Kt. 5.
11. P. to K. R. 3.	11. K. Kt. to K. R. 3.
12. K. Kt. to Kt. 3.	12. Q. Kt. to K. B. 3.
13. Q. to Q. B. 2.	13. K. to R.
14. Q. Kt. to K. 4.	14. P. to Q. R. 3.
15. Q. Kt. takes Kt.	15. K. B. takes Kt.
16. B. takes K. R. P.	16. B. to Q. 5. (ch.)
17. K. to R.	17. Q. to K. R. 5.
18. Kt. to K. 2.	18. B. takes K. R. P.
19. P. to Kt. 3.	19. Q. to K. Kt. 5.
20. Kt. takes K. B.	20. B. takes R.
21. K. to Kt.	21. Q. takes Kt. P. (ch.)
22. K. takes B.	22. Q. B. P. takes Kt.
23. K. B. to Q. 3.	23. Kt. to K. Kt. 5.
24. K. B. to K. 4.	24. Q. R. to K.
25. Q. to K. Kt. 2.	25. R. takes K. B. P. (ch.)
26. B. takes R.	26. Q. takes B. (ch.)
27. K. to Kt.	27. R. takes B.
28. R. to K. B.	28. Q. to K. 6 (ch.)
29. K. to R.	29. Kt. to K. B. 3.
30. R. to K. B. 3.	30. R. to K. R. 5 (ch.)
31. Resigns.	

Mr. Medley.	Mr. Harrwitz.
1. P. to K. 4.	1. ———
2. P. to Q. 4.	2. P. to K. 3.
3. K. B. to Q. 3.	3. P. to Q. B. 4.
4. P. to K. 5.	4. P. to K. Kt. 3.
5. P. to K. R. 4.	5. P. takes Q. P.

Mr. Medley.	Mr. Harrwitz.
6. P. to K. B. 4.	6. K. Kt. to K. 2.
7. P. to K. R. 5.	7. K. B. to K. Kt. 2.
8. Q. to K. Kt. 4.	8. K. to B. 2.
9. K. Kt. to B. 3.	9. Q. Kt. to B. 3.
10. K. Kt. to Kt. 5 (ch.)	10. K. to Kt.
11. P. takes P.	11. K. Kt. takes P.
12. Kt. takes K. R. P.	12. Q. Kt. takes K. P.
13. P. takes Kt.	13. Kt. takes P.
14. Q. to K. Kt. 3.	14. Kt. takes B. (ch.)
15. Q. takes Kt.	15. P. to Q. 4.
16. Q. B. to K. Kt. 5.	16. Q. to K.
17. B. to K. B. 6.	17. Q. to K. B. 2.
18. B. takes B.	18. Q. takes B.
19. R. to K. R. 3.	19. K. to K. B. 2.
20. Q. Kt. to Q. 2.	20. P. to K. 4.
21. R. to K. B. 3 (ch.)	21. K. to K. 2.
22. Kt. to K. B. 6.	22. R. to R. 8 (ch.)
23. Q. Kt. to K. B.	23. Q. takes K. Kt. P.
24. Castles.	24. Q. to K. Kt. 4. (ch.)
25. K. to Q. Kt.	25. P. to K. 5.
26. Kt. takes K. P.	26. P. takes Kt.
27. Q. takes P. (ch.)	27. K. to Q. 2.
28. Q. takes P. (ch.)	28. K. to Q. B. 3.
29. Mates in three moves.	

Consultation and Correspondence Games. There are not only many other kinds of openings and descriptions of odds which might be illustrated did space permit, but we might also give specimens of *consultation games*, in which a number of players divide themselves into two committees, each with a board and men in different parts of the room, and the best move is discussed before it is made; the pieces, however, are not allowed to be touched before the move is decided on. A first-rate player will sometimes play against a whole club in consultation. Consultation games have been played between the clubs of two distant towns, the moves being transmitted by means of the electric telegraph. Then there are *correspondence games*, in which the moves are sent through the post. In this case the pieces are allowed to be moved in order to decide on the best move. Games of this kind are long and tedious, and may last some years, as in the contest between the clubs of London and Paris, London and Edinburgh, &c.

Ends of Games.—It frequently happens that after playing some time there are only one or two pieces or pawns left on the board, and it is then a question whether either player have mating-power. Should one player be left with his K. and Q., against his adversary's K., he can win easily. Such is also the case with K. and R. against K., only the mate requires a larger number of moves. The K. and two Bs. against K. also win. The K. B. and Kt. against K. can win, but the mate is difficult. The K. and two Kts. against K. usually make a drawn game. The K .and two Rs. against K. and R. win, by forcing an exchange of rooks. K. and Q. against K. and R. usually win, but the weaker force can sometimes produce a stale-mate. K. and Q. against K. and two Kts., or two Bs., or Kt. and B., or R. and Kt., or R. and B. usually win. K., two Bs., and Kt. against K. and R., win. K. and R. against K. and B. usually make a draw. K. and R. against K. and Kt., also usually draw. K. and R. and B. against K. and R., is a doubtful case, but this, as well as some of the above, depend upon position.

Towards the end of the game the kings become useful pieces, and may act with great effect. The fate of a game often depends on being able to take what is called the *opposition*, that is, to place your king opposite to the adverse king, either on a file or a diagonal, so as to

Diagram 11.

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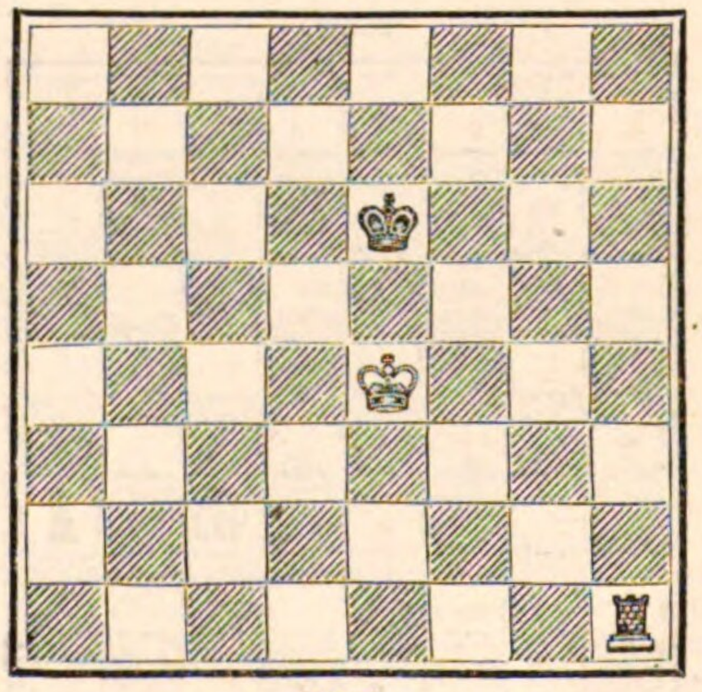

WHITE.

have an odd number of squares between them: you thus gain the opposition or the *move*. This may be illustrated by a few examples.

In the annexed position (*Diagram* 11) your king is in opposition, and the object is to force the king to one of the sides of the board, when the mate is given by the rook.

1. R. to K. R. 6 (ch.)	1. K. to K. 2.
2. K. to K. 5.	2. K. to Q. 2.
3. R. to K. Kt. 6.	3. K. to Q. B. 2.

If he had played back to his K. second, you would have checked at knight's seventh, and have forced him to the side of the board, but you now lose a move to see how he will play.

4. K. to Q. 5.	4. K. to Q. Kt. 2.
5. K. to Q. B. 5.	5. K. to Q. R. 2.
6. K. to Q. Kt. 5.	6. K. to Q. Kt. 2.
7. R. to K. Kt. 7 (ch.)	7. K. to Q. B.
8. K. to Q. B. 6.	8. K. to Q.
9. R. to Q. R. 7.	9. K. to K.
10. K. to Q. 6.	10. K. to K. B.
11. K. to K. 6.	11. K. to K. Kt.
12. K. to K. B. 6.	12. K. to K. R.
13. K. to Kt. 6.	13. K. to K. Kt.
14. R. to Q. R. 8, Check-mate.	

After this example it will be easily understood, that if the R. were exchanged for the Q., the mate would be more easy. The following

DIAGRAM 12.

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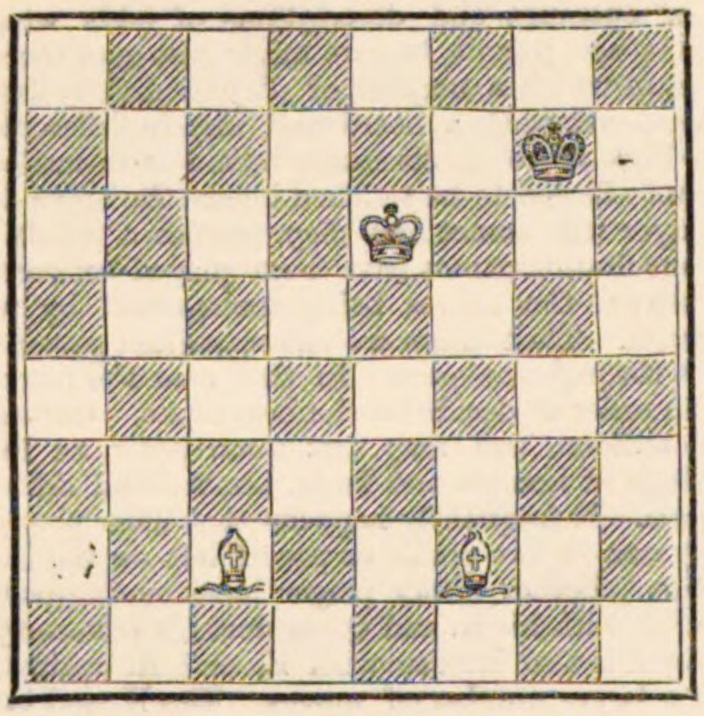

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position will serve to illustrate the nature of the mate with K. and two Bs. against K.

1. Q. B. to K. 3.	1. K. to K. B.
2. K. B. to K. Kt. 6.	2. K. to Kt. 2.
3. K. B. to K. R 5.	3. K. to K. B.
4. Q. B. to K. R. 6 (ch.)	4. K. to K. Kt.
5. K. B. to K. Kt. 6.	5. K. to K. R.
6. K. to K. B. 6.	6. K. to K. Kt.
7. K B. to Q. 3.	7. K. to K. R.
8. K. to K. Kt. 6.	8. K. to K. Kt.
9. K. B. to Q. B. 4 (ch.)	9. K. to K. R.
10. Q. B. checkmates.	

The K. and two Kts. against K. cannot be forced; but if Black have a

Diagram 13.

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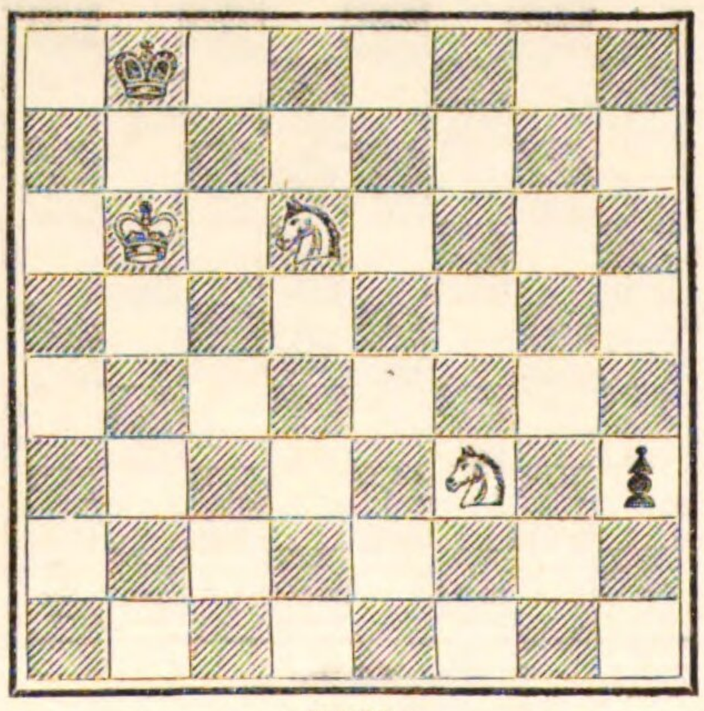

WHITE.

pawn, the game may sometimes be won, since Black having a pawn

to move, is not stale-mated. The above (*Diagram* 13) is a case in point:—

1. Kt. to Q. 4.	1. P. to K. R. 7.
2. Kt. to Q. B. 6 (ch.)	2. K. to Q. R.
3. Kt. to Q. Kt. 5.	3. P. queens.
4. Kt. to Q. B. 7, Check-mate.	

These examples will suffice to illustrate the principle of mate, when there are only one or two pieces on the board. Some of the most refined and beautiful points of chess refer to pawn-play, which generally occupies an important chapter in every treatise on chess. It often

Diagram 14.

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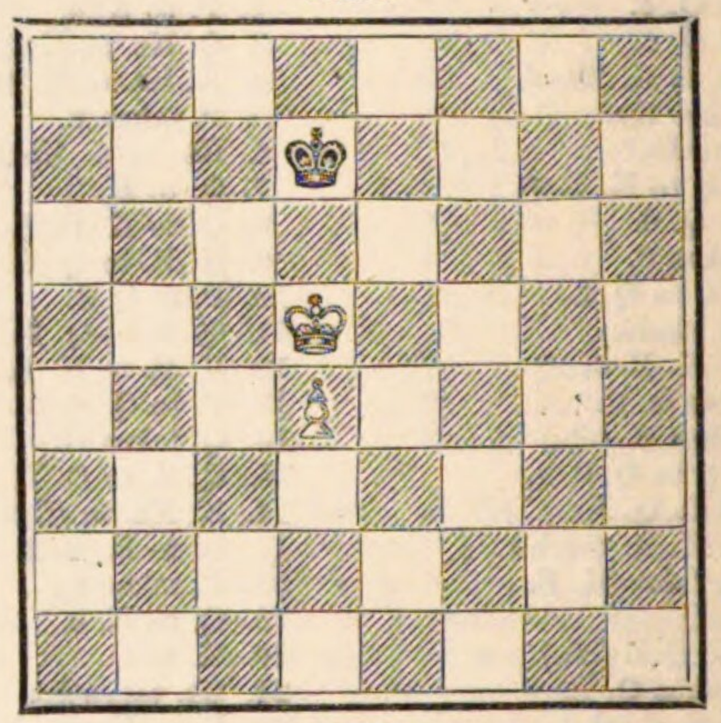

WHITE.

happens, that in cases of K. and P. against K., the K. can get immediately in front of P. before the P. reaches its sixth square. The game is then drawn. For example, in the position (*Diagram* 14):—

1. K. to Q. B. 5.	1. K. to Q. B. 2.
2. P. to Q. 5.	2. K. to Q. 2.
3. P. to Q. 6.	3. K. to Q.
4. K. to Q. B. 6.	4. K. to Q. B.
5. P. to Q. 7 (ch.)	5. K. to Q.
6. K. to Q. 6.	6. Is stale-mated.

In some positions the winning of the game depends upon who has the move; but in certain cases, similar to the following (*Diagram* 15),

Diagram 15.

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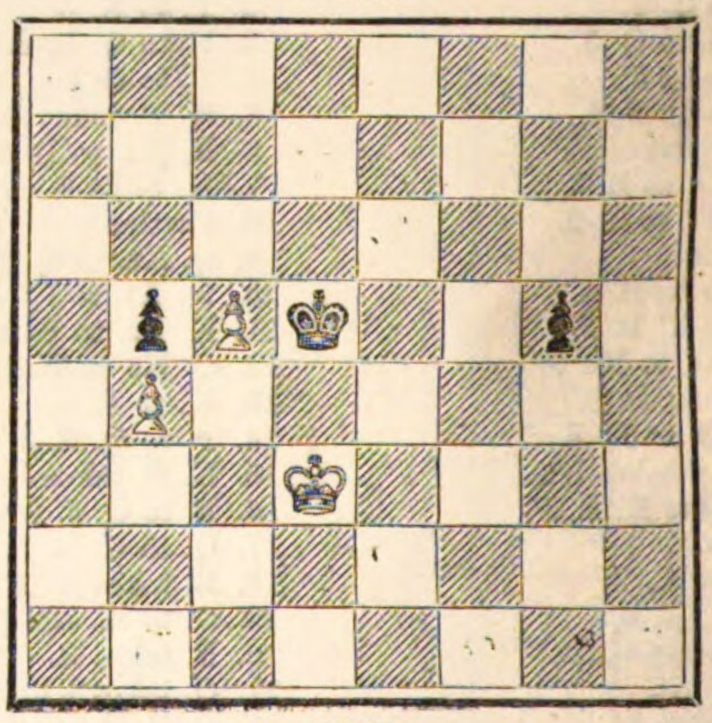

WHITE.

of two united pawns against two isolated pawns, White can win, whether he move first or not, for while the white K. can stop the advancing P., the black K. cannot play to Q. B. fifth, or capture the hindermost pawn, without the passed pawn moving on to queen. With the best play, however, this position is drawn.

1. K. to K. 3.	1. K. to K. 4.
2. K. to K. B. 3.	2. K. to K. B. 4.
3. K. to K. Kt. 3.	3. K. to K. 4.
4. K. to K. Kt. 4.	4. K. to K. B. 3.
5. K. to Kt. 3.	5. K. to K. 4.
6. K. to B. 3.	6. K. to B. 4.

By this line of play the game is drawn.

Problems.—A department of chess which has called forth a large amount of ingenuity is the composition of problems, in which a certain position being given, one colour (generally white), is required to give

mate in a certain number of moves. Problems differ from *end games* in this, that whereas the latter are actual positions which have occurred, or might occur in play, the former may be built up or constructed, so as to carry out some idea of the composer. In certain cases, unusual conditions are attached to the solution, such as, that the mate is to be given with a particular pawn or piece, or on a particular square, or without touching certain pieces, or to check every move, or not to check until mate is given, or to compel your adversary to check-mate you, &c., &c. These absurd conditions are much better avoided, the best problems being made as natural as possible. Some composers make their problems in the shape of natural objects, such as an egg, a sword, a pyramid, a comet, &c., which is even more absurd than the conditions. We append three or four problems of great beauty and originality, together with their solutions.

No. 1. By CALVI.

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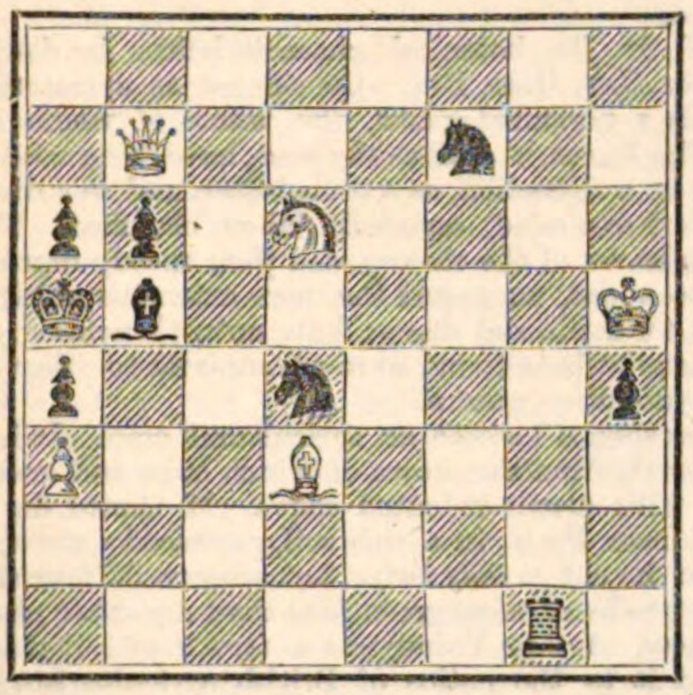
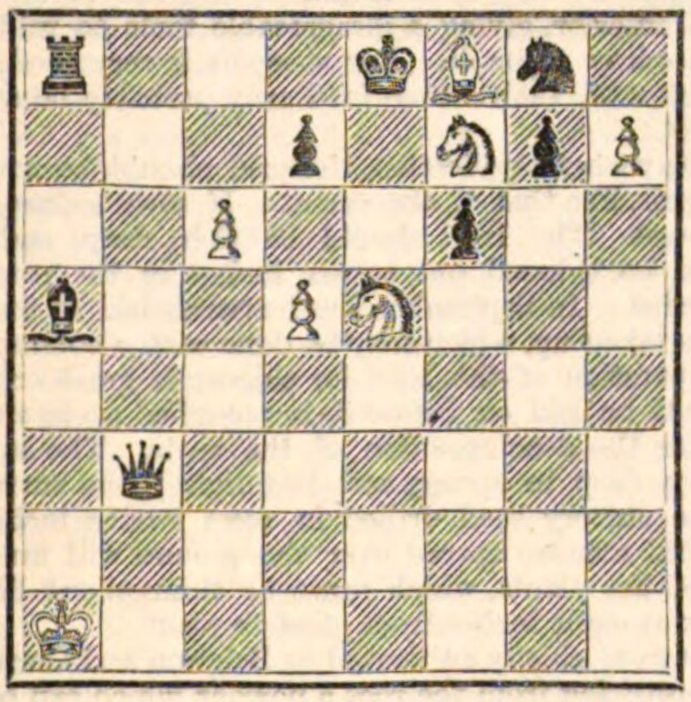


WHITE.

WHITE MOVING FIRST, IS TO CHECKMATE IN TWO MOVES.

No. 2. By D'ORVILLE.

BLACK.

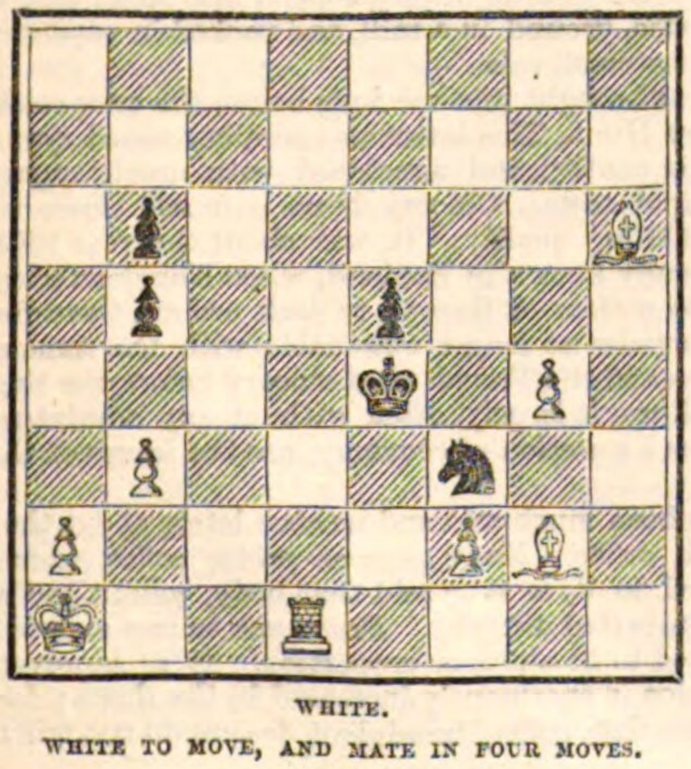


WHITE.

WHITE TO MOVE, AND TO CHECKMATE IN THREE MOVES.

No. 3. By SHAGIRD.

BLACK.

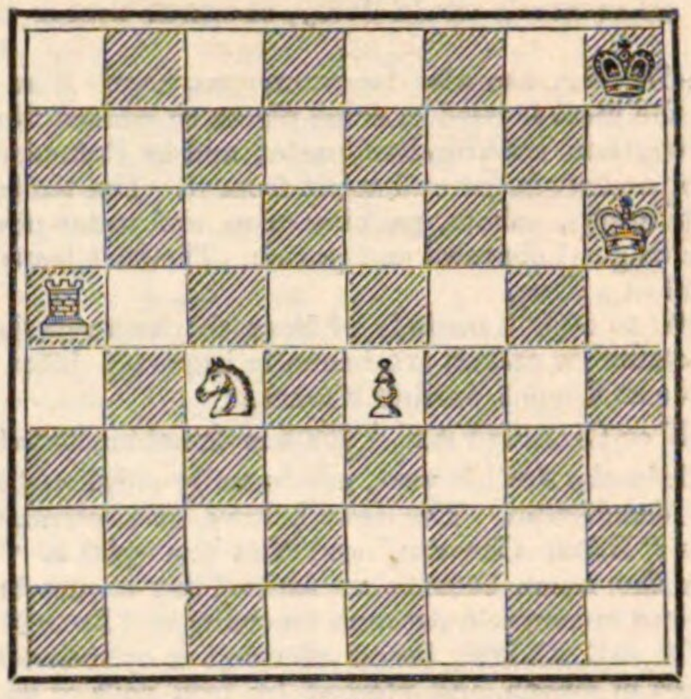


WHITE.

WHITE TO MOVE, AND MATE IN FOUR MOVES.

No. 4. THE CAPPED PAWN.

BLACK.



WHITE.

The above is an example of the *Pion Coiffé*, or "Capped Pawn," in which, at the commencement of the game, one of the players puts a paper cap or a ring over a particular pawn, and undertakes to checkmate his adversary with that pawn, without being allowed to queen it. In the above position, which is supposed to represent the end of such a game, White having to move is to give checkmate with the pawn in four moves.

SOLUTIONS.

No. 1.

WHITE.	BLACK.
1. Q. to K. Kt. 2.	1. Any move.
2. Q. or Kt. mates.	

No. 2.

1. P. takes P. (ch)	1. K. takes B.
2. Kt. to K. 6 (ch.)	2. K. takes Kt.
3. K. R. P. queens becoming a Kt., check-mating.	

No. 3.

1. K. to Q. Kt.	1. P. to Q. Kt. 5.
2. B. to Q. B.	2. P. to Q. Kt. 4.
3. R. to Q. 2.	3. K. moves.
4. R. to Q. 4 (ch.), disc. check and mate.	

No. 4.

1. R. to K. 5.	1. K. to Kt.
2. R. to K. 8 (ch.)	2. K. to B. 2.
3. Kt. to Q. 6 (ch.)	3. K. to B. 3.
4. P. mates.	

The solution of a problem should not be discovered by setting up the position and moving the pieces about, but by the mental process of studying the diagram and so working it out.

CHESTNUT, or CHESNUT; ECONOMICAL USES. This tree is available for a great variety of uses in the arts and domestic economy. There are two kinds, the *Sweet Chestnut* and the *Horse Chestnut*.

The *Sweet Chestnut* is in most cases cultivated more for its fruit than for any other purpose. In England the chestnut is eaten in many ways—raw, roasted, stewed with cream, made into soup either with milk or gravy, stewed with salt-fish, or used as a stuffing for fowls and turkey. Evelyn speaks of the chestnut as being "a lusty and masculine food for rustics at all times, and of better nourishment for husbandmen than kale or rusty bacon; yea, or beans to boot." In the south of France and the north of Italy, chestnuts serve in a great measure as a substitute for bread and potatoes. The nuts laid by for winter vegetable are those which fall off the trees; while those which are beaten off are carried to Paris and other large towns for immediate use. As a means of depriving the nuts of their husks, they are trodden under foot by men wearing *sabots*, or wooden shoes. Chestnuts are dried in France, and preserved for many years; they are dried by the air, by the sun's heat, by a kiln, or by partial boiling, according to the mode in which they are to be used. The French make many dishes from chestnuts. *Galette* is a thick flat cake made with chestnut-meal, milk, salt, and sometimes a little butter and eggs, and baked on a hot stove or iron plate. *Polenta* is a thick porridge made by boiling the chestnut-meal in water or milk, and stirring it till it forms a thick paste, something like the oatmeal parritch of the Scotch. *Chatigna* is made by boiling the nuts whole, without their skins, in water with a little salt, till they become soft, and then mixing them up like mashed potatoes. *Marrow-glace* is made by dipping the nuts into clarified sugar, and then drying them. The nuts are also frequently cooked by boiling them in water containing the leaves of celery or sage.

The timber of the sweet or Spanish chestnut is much used for posts, fences, stakes, hoops, &c. The wood is more fitted for such purposes

than for beams or plants, as it is liable to become rent with fissures. It is used in France for making wine-casks; and for many purposes where most other woods would decay, chestnut timber is found very desirable.

The *Horse-Chestnut* has also its numerous uses. The fruit is eaten by animals: the meal is used in some places to whiten flaxen cloth; in others, to strengthen bookbinders' paste; and in France attempts have been made to produce sugar and spirit from it. The timber is used for flooring, cart-linings, sabots, packing-cases, and water-pipes; on being burned, it yields good charcoal and potash. The bark is used in tanning, in dyeing, and as a drug.

From 60,000 to 80,000 bushels of Spanish chestnuts (as the fruit of the sweet chestnut is called) are annually imported into this country, mostly for sale at Covent Garden Market.

CHESVAN or CHESHVAN, חֶשְׁוָן, is the abbreviated name of the second month in the Jewish year, now usually employed instead of the proper term Marchesvan. The Jews believe, or pretend, that the full word implies "Bitter Chesvan," and that the epithet "bitter," *mar*, was added to the name, because no festival day occurs in the month! They leave it out in common parlance accordingly. [Bul; Marchesvan.]

CHEVAUX DE FRIZE, beams of wood or cylinders of iron, from six to nine feet in length, and pierced by iron rods or wooden pickets six feet long, which are pointed at each end and shod with iron; the pickets are placed six inches asunder, and pass through two opposite faces of the beam in directions alternately at right angles to each other, the cheval resting on the ground at the lower extremities of the pickets. A series of these, disposed in lines and connected together by chains, are placed in the ditch, on the berme, at the entrances or behind the glacis of a field fort; or on the breach made in the rampart of a fortress, in order to impede the enemy at the time of making an attack. The chevaux de frize made for the British service consist of hollow cylinders of iron in six feet lengths, sufficiently large in diameter to contain the iron rods or pickets when removed, for the purpose of packing for transport, from their positions in the holes made at right angles to one another in the cylinder, and into which they are fixed by keying or turning half round, after a projection on their surface has passed through a corresponding indent in the hole in the cylinder.

Chevaux de frize, on account of their portability and the facility with which they can be put together or taken to pieces, were much esteemed formerly, and were employed in the open field as a protection against charges of cavalry; but they are now seldom used for this purpose, being easily deranged by the enemy's artillery.

When Badajos was besieged in 1812, chevaux de frize, formed by sword-blades fixed in beams of wood, were planted by the defenders on the breaches in the Trinidad bastion and in the adjoining curtain, where they proved a fatal obstacle to the troops engaged in the memorable assault on that fortress.

CHEVY CHACE, the name of an old English ballad, founded upon the history of a hunting encounter which took place in 1388 at Atterburn, upon the south of the Cheviot Hills, between the martial families of Percy and Douglas. The older version of this ballad was first printed by Hearne, from a manuscript in the Ashmolean Museum at Oxford, and afterwards by Bishop Percy in the 'Reliques of Ancient English Poetry.' It begins,

"The Perse owt of Northomberlande."

According to a communication made by the Rev. J. J. Conybeare to the editors of the 'British Bibliographer,' there is now little doubt that the author of this ballad was one Richard Sheale, who dwelt at Tamworth, whom Percy and Ritson both agreed to consider as the transcriber only of the Ashmolean copy. The style of this ballad is rugged and uncouth, and it is written in the very coarsest and broadest northern dialect. There seems the best reason for believing that its composition may be dated about or soon after 1540.

The more modern ballad of Chevy Chace, that of which Addison has criticised the beauties in the 'Spectator' (Nos. 70, 74), begins,

"God prosper long our noble king."

Bishop Percy ascribes this version to the time of Queen Elizabeth, and it was probably late in her reign when it was written, or Sir Philip Sydney would have had no occasion to lament that the ballad of Chevy Chace, in his time, was so "evil-apparelled in the rugged garb of antiquity."

Bishop Percy has printed both ballads in his 'Reliques.'

CHIAROSCU'RO is a branch of painting, the object of which is to combine and arrange the light and dark parts of a picture to the best advantage. It has reference to the lights and shadows of the picture as a whole, however, and not to the mere natural lights and shadows of the several objects—in other words, it relates to what may be called the composition of light and shadow.

The term chiaroscuro is derived from two Italian words, *chiaro*, light, and *oscuro*, dark, and includes the treatment of bright and dark colours or tints, as well as simple light and shade. It is by chiaroscuro that relief and depth, and what is termed the *effect* of a picture, are produced; by a judicious contrast of bright colours with dark, or a combination of the two, or by their gradual blending; by involving one part of the picture in shadow, while another part stands forth in full light; or by making the light gradually die away into the shadows. Leonarda da Vinci was the first who reduced the art of chiaroscuro to any thing like a system. It was afterwards practically improved by Correggio and by Titian, under whom it may be said to have attained perfection. It gives to Rubens his richness and brilliancy, to Rembrandt his magical luminousness. It must however always remain, from its nature, difficult to teach or subject to rules. To acquire excellence in the use of chiaroscuro, the student should study the properties of light, and the mode in which it is diffused, reflected, and separated into colours. He should refer to the works of the best masters, and observe the means which they have employed to imitate nature; and, above all, he should constantly watch and note down the effects of light and shade as exhibited in the objects around him under various modifications. The most powerful effects in painting will always be the nearest to nature; and the most pleasing will be those which are best selected out of the infinite variety which she presents for our choice.

CHICORY, in its botanical characteristics, is described under Cichorium, in Nat. Hist. Div. Considered as a material for every-day use, it is a perennial plant, the whole of which is bitter and aromatic. The leaves, as well as the root, have been used in medicine, in the form of a decoction, as a tonic bitter, and as a diuretic. It is frequently used as a salad, especially when blanched. The luxuriant growth of the leaves of the chicory, and their speedy reproduction after they have been cut, suggested the more extensive cultivation of this plant as food for cattle and sheep; but, notwithstanding its abundant produce, it has not been found so much superior to other green food as to make its cultivation general.

Chicory has thence become an agricultural crop. It has a fusiform root like a carrot, from the crown of which large and succulent leaves spread out, with deeply-indented edges. M. Cretté de Panuel, who cultivated it near Paris, in a rich soil, produced extraordinary crops. The first year he cut it only twice, but afterwards four and five times in a year: it produced more green food than any other plant cultivated for this purpose. Arthur Young was so struck with it that he strongly recommended it to the notice of British agriculturists; and in the queries sent to various parts of the country by the Board of Agriculture, one was, whether chicory was cultivated in the district as green food for cattle. Some accurate experiments on a large scale were made in France at the national farm of Rambouillet, to ascertain the value of chicory compared with lucerne and other green food. The chicory was declared inferior, giving a disagreeable taste to milk and butter when cows are kept upon it. For sheep it is very good, and a small portion mixed with their other food may probably be a preservative against the rot.

To have the roots in perfection, the seed should be sown, or rather drilled, in April, like that of the carrot. If sown sooner, they are apt to run to seed. The land should be rich, deep, and light. The plants should be thinned out to six inches in the rows, and most carefully weeded. In September the leaves should be finally gathered and the roots taken up, which may be done with a common pitch-fork. The best preparation of the land for chicory is grass or clover. The manure should be laid on before it is ploughed up in autumn, which will accelerate the decomposition of the roots. The land should be ploughed very deep in spring, and laid light; the surface harrowed fine, and the chicory seed drilled in rows twelve inches apart, and rolled. Liquid manure spread over the ground will much accelerate the growth of the plants, which must be thinned out like turnips or carrots to six or eight inches from plant to plant.

Chicory is now chiefly cultivated in Belgium and Germany, for the purpose of preparing from the root a powder which can be substituted for coffee. The roots, when taken up in September, are cleaned by scraping and washing, split where they are thickest, and cut across in pieces about two or three inches long; these pieces are dried by means of a slow oven or a kiln. In this state it is sold to the merchants, packed in bags. It is afterwards cut or chopped into small pieces, and roasted exactly as coffee, ground in a mill, and packed in papers in pounds and half-pounds for retail sale.

Chicory was brought into use long before the once celebrated *roasted corn* of Henry Hunt. This latter was simply roasted rye; and, although used in large quantity, and sweetened with much sugar, it had but a flat and insipid taste. Chicory bears a much closer resemblance to coffee of middling quality. It was about the year 1808 that chicory became generally known in England, when Napoleon's anti-commercial policy led the nations of Europe to look around them for various substitutes for articles no longer obtainable with the same ease as before. The Germans and the French used chicory before the English; and the Germans still use it largely, often without any admixture with coffee. They even, as a question of economy, use the leaves of the plant in the same way.

There has been much said and written lately about the admixture of chicory with coffee. Many persons prefer coffee which has a little chicory added to it, as it is said that body, colour, and a soft pleasant aroma are imparted thereby. From one to two ounces to a pound of coffee is stated to be a proper proportion. It is however known that this proportion is enormously increased in the shops; for as chicory is much cheaper than coffee, fraudulent dealers do not fail to avail them-

selves of the circumstance. It is known that the very low-priced coffee of such vendors sometimes contains as much as two-thirds chicory to one-third pure coffee. If purchasers bought their coffee *whole*, and ground it at home, they might at once defeat this fraud. When coffee is over-chicoried, it acquires a mawkish taste, intermediate between those of treacle and liquorice; and its frequent use has a tendency to disarrange the digestive system.

The chicory trade has undergone some curious changes. The root was first imported in 1832, at the same duty as colonial coffee, with an imperative condition that the two should be sold separated, not mixed. In 1840, when the prices of tea and coffee were high, the Treasury issued an order, permitting chicory to be sold mixed with coffee, producing a compound that could be sold at a moderate price. Then arose a singular struggle: the coffee-merchants looked with suspicion on any encouragement given to chicory, as being likely to injure their trade; while the chicory-dealers insisted that fair play ought to be given to the commodity in which they dealt. Chicory was now grown in England, and was admitted into the market duty free; whereupon the coffee-merchants said, "Either tax chicory, or remove the tax from coffee." A few years afterwards, the consumption of chicory in England was variously estimated at from 18 to 28 millions of pounds annually. In 1852 a Treasury order appeared, forbidding the mixture of chicory with coffee in the same packet; but afterwards the conflict was thus settled: chicory may be sold mixed with coffee, but the fact of the admixture must be stated on a printed wrapper.

The extent to which coffee is adulterated by chicory is very great; the dishonest traders have a temptation to sophisticate, when coffee is from three to six times the price of chicory. But this is not all: chicory itself is adulterated. Samples of chicory purchased at retail shops have been chemically analysed, and have been found to contain carrot, parsnip, mangel-wurzel, beans, acorns, roasted corn, biscuit-powder, and burnt sugar; a few specially vile compounds were found to contain sawdust, red earth, burnt rags, and oakum or rope-yarn.

CHIEF JUSTICE. [COURTS.]

CHILBLAIN, a local but peculiar inflammation of the skin commonly appearing under one of three forms. The mildest form is attended with redness, swelling, and a sense of itching, often quite intolerable. In the second or severer form the colour of the swollen part is of a deeper red, sometimes of a dark blue colour, and at other times even of a purple hue. In the third or the severest form, small vesicles rise on the surface of the reddened and swollen skin, which are soon converted into sores, from which a thin irritating matter discharges, the irritating nature of which it is difficult to alter, or to bring the sores into a state of healthy suppuration.

That the inflammation of which this troublesome complaint is the consequence is of a peculiar kind, not very well understood, surgeons conclude because they find that it is not relieved by the applications which are most beneficial in ordinary inflammation.

The exciting cause of chilblain is always cold, and more especially cold applied after the part had been previously much heated. Hence those persons are most subject to the complaint who have contracted the bad habit of going immediately to the fire when they come home in winter with their fingers and toes very cold. Hence also the chief seats of the disease are those parts of the body which are most exposed to sudden alternations of heat and cold, as the nose, ears, lips, heels, and fingers. Young persons are more subject to it than adults, females than males, and it seems most frequently to attack persons of a fair skin.

The painful itching, which is perhaps the most troublesome part of this complaint, is best relieved by active and long-continued friction with camphorated spirits of wine, or with a mixture of two parts of camphorated spirits with one of Goulard's extract. Some surgeons speak highly of the efficacy of one part of the tincture of cantharides to six of the common soap liniment as a lotion. But "one of the best modes of curing chilbains of the milder kind is to rub them with snow or ice-cold water, or to bathe them in ice-water several times a day, keeping them immersed each time until the pain and itching abate. After the parts have been rubbed or bathed in this way, they should be well dried with a towel and covered with flannel or leather socks."

The stimulating applications, only in a more diluted form, appear also to be the best remedies when vesications arise. In this case the application of heat to the part affected should be most carefully avoided. When the vesicles terminate in sores, they require stimulating dressings.

But prevention is better than cure, and the most effectual mode of guarding against the annoyance of this irritating and often exceedingly protracted disease is to accustom the skin to moderate friction, to avoid clothing the parts too warmly, to avoid still more carefully sudden and great alternations of heat or cold; and accordingly to take particular care not to go immediately into a warm room or near a fire out of the cold air; and to wash the parts frequently with cold water. (Cooper's 'Surgical Dictionary.')

CHILD KILLING. [INFANTICIDE.]

CHILD STEALING. [ABDUCTION.]

CHI'LIAD (from χιλιάς) is (or rather was) used to mean a thousand consecutive numbers. Thus from 1 to 1000 forms the first chiliad, from 1001 to 2000 the second, and so on.

CHILTERN HUNDREDS. A portion of the high land of Buckinghamshire is known by the name of the Chiltern hills. "Formerly these hills were a forest, consisting principally of beech trees, whence probably the name of the county, from *buch*, German; *bece*, Anglo-Saxon, the beech-tree. These forests afforded shelter to numerous banditti. To put these down, and to protect the inhabitants of the neighbouring parts from their depredations, an officer was appointed under the crown, called the steward of the Chiltern Hundreds." [BUCKINGHAMSHIRE, in GEOG. DIV.] The duties have long since ceased, but the nominal office is retained to serve a particular purpose. A member of the House of Commons, not in any way disqualified, cannot resign his seat. A member therefore who wishes to resign, accomplishes his object by accepting the stewardship of the Chiltern Hundreds, which being held to be a place of honour and profit under the crown vacates his seat. This nominal place is in the gift of the chancellor of the exchequer. Similar offices are the manors of East Hendred, Northstead, and Hempholme, and the escheatorship of Munster, which are used for the like purposes, and are resigned immediately.

CHIMES, a set of bells tuned to the modern musical scale, and struck by hammers acted on by a pinned cylinder or barrel, which revolves by means of clock-work. The term is also applied to the music, the tune, produced by mechanical means from the bells in a steeple, tower, or common clock.

Chimes differ from carillons (as the last word is commonly understood in England), inasmuch as the bells of the former are acted on by clock-work, those of the latter by keys struck by the hand. But the French apply the term *carillon* to the tune played, and, generally, to the series of bells, whether sounded by machinery or by hand; though the most accurate writers distinguish the latter kind as *le carillon à clavier*. The *carillons à clavier* comprise three octaves of bells, sounded by means of keys, similar to the pedals of an organ, which the performer strikes forcibly with hands clenched and sideways, the little fingers being guarded by a thick covering of leather. These keyed-carillons are found in many towns of Holland and the Netherlands. At Ghent they are remarkable; but the best specimen is at Amsterdam, where the *carilloneur* (M. Pothoff, formerly an organist in that city) used to display an extraordinary command of the instrument, on which he executed pieces in three parts—the base by means of pedals—with a rapidity rarely exceeded by judicious performers on the organ.

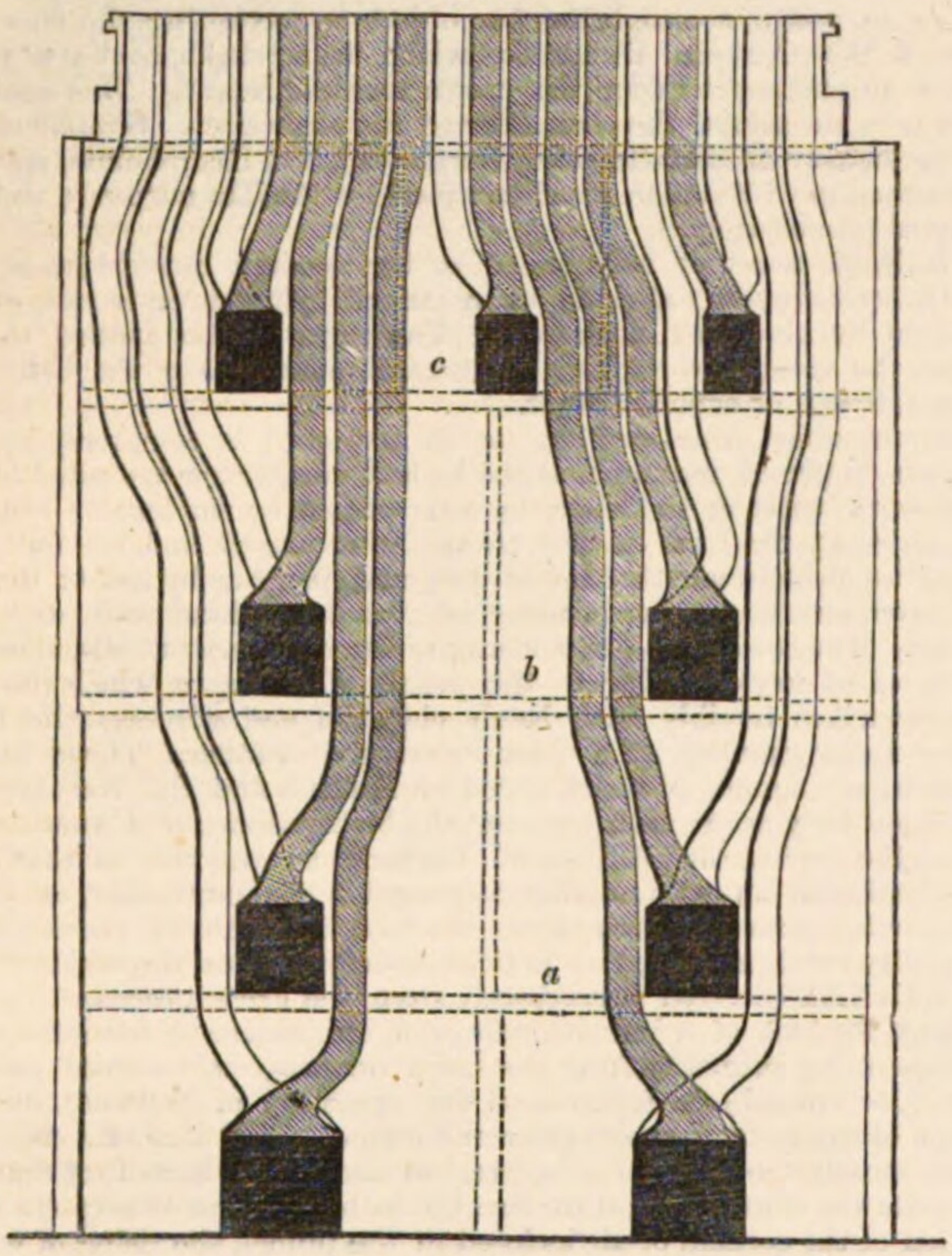
CHIMNEY (derived immediately from the French *cheminée*, which conveys the idea of a narrow passage, a diminutive or feminine form of *chemin*, but primarily from the Latin *caminus*), an enclosed passage funnel, or tunnel (see remarks on the etymology of TUNNEL), for the escape of smoke from a fire-place or furnace. The office of a chimney is not merely the removal of smoke, but also the production of draught to excite the combustion of the fire, by the heating and consequent rarefaction of the column of air inclosed in the funnel, the rising of which causes a partial vacuum, which should be filled with air admitted either through or over the burning fuel. [SMOKE; FURNACE; WARMING AND VENTILATION.]

The construction of house-chimneys is briefly treated of under HOUSE, but an explanatory diagram of a stack of chimneys is here introduced. But before so doing we shall enumerate, on the authority of Nicholson's 'Architectural Dictionary,' article "Chimney," the technical names given to the various parts of a chimney and fire-place. That which builders term the *fire-place* is the square recess or opening, facing the room, in which the stove is fixed or *set*. The *hearth* is the flat piece of stone, or marble, or metallic plate, immediately *under* the fire-place, while the large flat stone on the same level, but *before* the fire-place, though very commonly called the hearth, is technically called the *slab*. The vertical sides of the opening of the fire-place, and the projections from the face of the wall at each extremity of the slab, are the *jambs;* and the horizontal head of the fire-place, the ends of which rest upon the jambs, is styled the *mantel*. *Covings* are the oblique facings of stone, marble, or metal, sometimes applied to the inside of the jambs to reduce the space at the back of the fire-place. *Funnel* is a general name applied to the cavity or passage of the chimney, from the fire-place to the top of the wall, the lower part of which, where the sides are sloped so as to contract the passage from the dimensions of the top of the fire-place to those of the flue, is called the *gathering of the wings*, or simply the *gathering*. The *flue* is the long narrow passage which extends from the gathering to the top of the wall, and which, whatever may be its course, should be of equal dimensions throughout its whole length; and the *throat* is the lower end of the flue at its junction with the gathering. The *breast* is that part of the wall which faces the apartment, and forms that side of the funnel which lies parallel to it; and the *back* is the opposite wall of the flue, parallel with the breast, but at the side farthest from the apartment. *Withs* are the narrow partition-walls which separate one flue from another rising beside it, and which form the sides of the flue, the *breast* and *back* being considered the front and back. A *stack*, or *chimney-stack*, is a wall containing a number of chimneys or flues arranged side by side. The *chimney-shaft* is the turret rising above the roof, to conduct a chimney or stack of chimneys to a sufficient height; and the *chimney-top* is the horizontal termination of the chimney-shaft, which is commonly surmounted by *chimney-pots*, to contract the upper end of the funnels or flues.

In modern English houses it is a common practice to form the

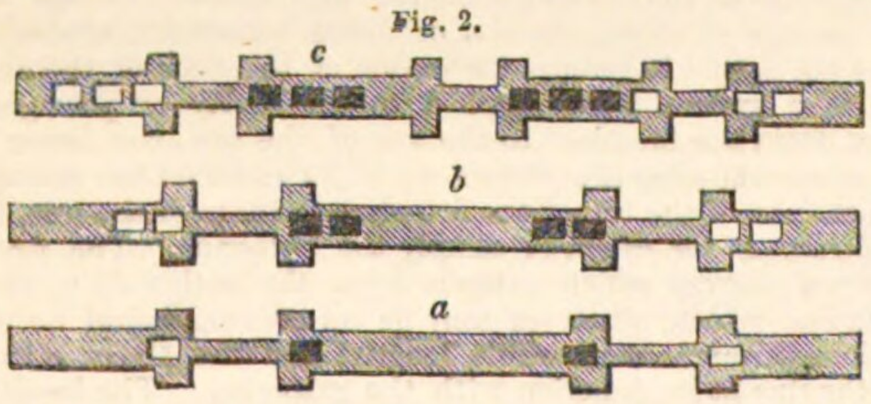
chimney-flues within the substance of the party-wall, an arrangement which, while it involves rather more brickwork than the older plan of forming them in the projecting jambs, has the advantage of leaving the width and projection of the jambs entirely dependent upon the taste of the architect. Where this plan is adopted in the case of two adjoining houses, the fire-places of which are back to back, the flues of two houses may be brought into one plane, as illustrated in the annexed diagrams, *figs.* 1 and 2. *Fig.* 1 represents the arrangement of the flues in a four-story house, having two fire-places on each of the three lower

Fig. 1.



floors, and three on the upper floor, making nine in all. Being one of two houses with their flues united into one stack, the number of separate flues required is eighteen; but to show the arrangement more distinctly, the flues of one house only are tinted, while those of the adjoining house, rising from fire-places in the same positions but on the opposite side of the party-wall, are left in outline. The fire-places are indicated by a dark tint, and the positions of the floors and partitions are shown by dotted lines. *Fig.* 2 represents transverse sections or ground-plans of the party-wall and flues, at the respective levels of the floors, *a*, *b*, and *c*, the flues of the one house being shown by a dark colour, while those of the other, left in outline in *fig.* 1, are shown white. If the stack were for a single house only, the arrangement of the tinted set of flues would need to be a little altered, so as to bring them close together in the chimney-shaft. Were the flues of the same house to be formed in the jambs, instead of being in the substance of the party-wall, the transverse section of the wall at the floor *a* would be

Fig. 2.



as in *fig.* 3, the inner jambs being widened to receive the flues from the basement story; but the arrangement of the flues in the upper

Fig. 3.

storeys would be altered, so as to distribute the flues as equally as possible on each side of the fire-places. It is however impossible in a lofty house, with flues of this description, to avoid the disfigurement of unequal jambs, since it will inevitably occur that in some cases a fire-place will have one flue in the one jamb and two in the other, or two flues on one side and three on the other. Another important advantage gained by placing the flues in the party-wall is, that the projection of the jambs and breast may be reduced from 14 inches, the projection necessary when the flues are in the jambs, to 4½ inches. This advantage is not apparent in the cuts here given, because where fire-places are made back to back they cannot be made to recede so far into the wall as in other cases, it being necessary to preserve a thickness of nine inches between the backs of the two fire-places. The variations from the straight vertical course necessary to enable the flues which rise from the fire-places of the lower storeys to pass beside the fire-places of upper storeys, are useful in checking the tendency of the chimneys to smoke, and are frequently increased for that purpose beyond the degrees necessary for their arrangement in the stack; but in making them it is very desirable to avoid angles and sudden turns, which encourage the lodgment of soot, and impede the operation of the sweeping-machine. It is hardly needful to observe here the importance [SMOKE] of avoiding the communication of one flue with another. Such an arrangement is now very rarely permitted, excepting in the case of a copper or oven flue, which is frequently turned into a kitchen flue, instead of being carried up separately to the top of the stack.

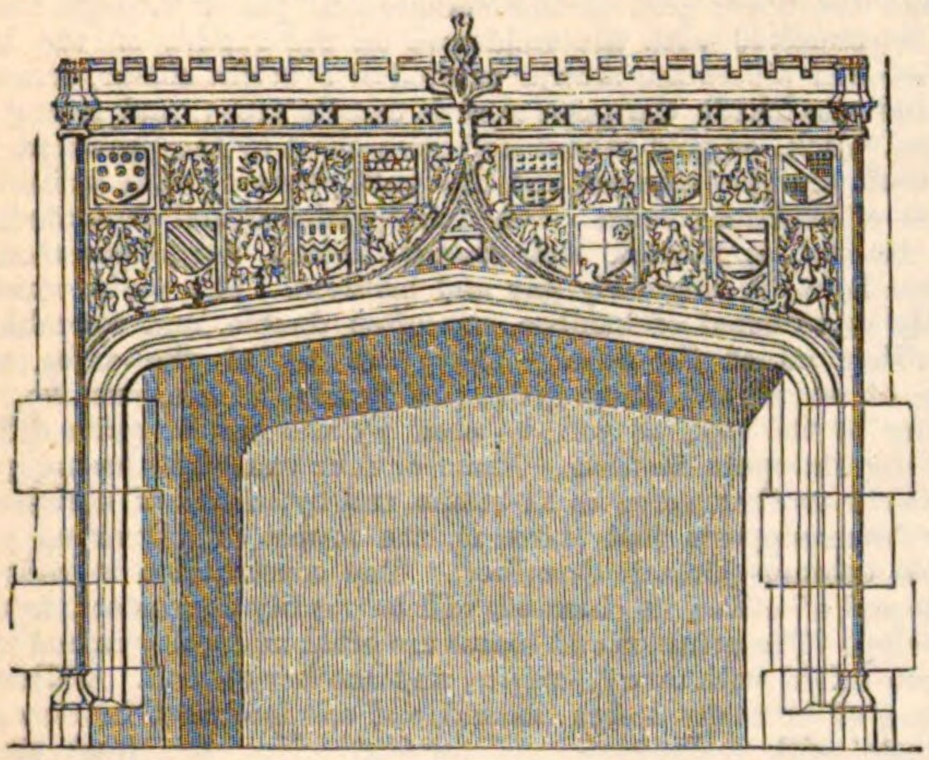
Indispensable as chimneys now appear, they are of comparatively modern invention. Beckmann, who gives a long dissertation on their early history, with numerous references to passages in ancient writers bearing upon the subject ('History of Inventions,' English edition of 1814, vol. ii. pp. 62-101), says that the oldest certain account of chimneys with which he was acquainted occurs in the year 1347, when several chimneys at Venice were thrown down by an earthquake; but they were not in general use until long after that time.

On the subject of engine and factory chimneys the reader may consult Dr. Ure's 'Dictionary of Arts,' article 'Chimney,' where it is stated that the celebrated Montgolfier was the first to investigate the general principles of chimney-draughts, as applied in manufacturing establishments. Dr. Ure gives sectional and other diagrams of one of the immense and yet beautiful chimneys at the Camden Town station of the London and Birmingham (now London and North-Western) Railway, connected with the furnaces of the stationary engines for working the Euston inclined plane, subsequently removed. Hebert, 'Engineer's and Mechanic's Encyclopædia,' vol. i. p. 364, describes a curious mode of constructing chimneys with circular flues enclosed within common brick flues of an octagonal form, in such a manner that the inner flue, which forms the only passage for the smoke, is surrounded by a current of hot air supplied by enclosed chambers at the back of the fire-place, the effect of which is greatly to improve the draught. The internal flue is formed of a peculiar wedge-shaped kind of brick, which affords facilities for the formation of curves without any roughness or irregularity in the work, whenever it is desired to conduct the flue in a serpentine direction. This plan, which is patented by Mr. Hiort, is said to have been adopted in several public buildings with success. In the better sort of houses the flues are sometimes so constructed that they may be swept from openings in the basement story, without any communication with the rooms into which the fire-places open.

The celebrated chimney of the St. Rollox chemical works, near Glasgow, was not less than 450 feet in height, from foundations to top, its diameter at the ground line being 40 feet, and at the top 13 feet 6 inches. The chimney, subsequently destroyed, of Mr. Muspratt's soda ash manufactory, near Liverpool, was 406 feet high above the ground, 45 feet diameter at the base, and 9 feet diameter at the top; and the chimney of the Edinburgh gas-works is not less than 341 feet 6 inches high. In the 'Civil Engineer and Architect's Journal,' and in the 'Builder' (*passim*), many interesting statistics connected with this branch of construction are to be met with; whilst the theoretical principles it involves are to be found in Peclet's 'Traité de la Chaleur.'

CHIMNEY-PIECE, the assemblage of architectural dressings around the open recess constituting the fire-place in a room, and within which the fuel is burnt, either immediately upon the hearth itself, or in a raised grate or open stove. Accordingly, the fire-place being the spot around which persons naturally group themselves in an apartment, or near which they take their station—literally the focus of the domestic circle—the chimney-piece has always been made a principal object, and a chief point for decoration, so much so as to be considered almost essential to the character of a sitting-room; for though an equal degree of warmth and a more equable temperature may be obtained by means of flues for hot air, a room has a rather blank and comfortless appearance without a fire-place; and though its want may not be felt, the chimney-piece is missed as an architectural feature, there being about the same want of expression when it is absent as there is in a house which shows no chimneys. Both chimney-shafts and chimney-pieces were therefore properly made significant and ornamental features in our ancient domestic architecture. For a long time indeed, fire-places were used only for one or two principal rooms in a building, and were of very rude and primitive design, the funnel of the chimney projecting into the room, and sometimes sloping forward, downwards, and the opening for the fire-place being a simple arch, with scarcely any attempt at ornament. The more ancient examples are those of mere fire-places rather than chimney-pieces. In domestic architecture much was exceedingly uncouth and inconvenient, at the time when the Gothic style had attained in ecclesiastical edifices what has been considered by many its highest perfection. But as soon as

some degree of architectural refinement began to be introduced into the habitations of nobles, external dressings constituting a chimney-piece were added to the fire-place. The annexed example of one from Tattershall Castle, Lincolnshire, may serve as a type for such internal



feature where the Gothic style is employed, both on account of its fitness and propriety of character, and the happy union of simplicity with richness. It exhibits the style characteristically as employed for that particular purpose and no other, by those who were familiar with it, and who therefore did not, like some modern Gothic designers, look to tombs and gateways for ideas for chimney-pieces. Some other examples—one from the same building, and two from Windsor Castle—are given in Pugin's 'Gothic Specimens,' all of them very similar in their general character and proportions, in which respect and in regard to compactness and simplicity of composition they accord much more nearly with modern taste, and have a less 'Gothic' air than the cumbrous and extravagantly ornamented chimney-pieces in the Renaissance style of the Continent and our own Elizabethan. In these the design was carried quite up to the ceiling so as to form a sort of architectural frontispiece, composed of two or more stages piled up on each other, adorned with columns, pilasters, caryatides, termini, niches, &c., and presenting an overloaded mass of carving and sculpture. But though such compositions were generally exceedingly capricious, and equally fantastic and coarse in detail, some were real works of art—truly admirable for artistic beauty of design and masterly execution. In the palace of Fontainebleau were many sumptuous structures—for so they may be called—of the kind, and among those still remaining is the one in the ball-room, originally decorated with two bronze caryatides, larger than life, but for which columns are now substituted. Various magnificent examples, of the same period, occur in the Low Countries; two noted ones in the Hôtel de Ville at Courtrai, and one of matchless beauty for its exquisite carvings in chestnut-wood, in the Hôtel du Franc at Bruges. In our own country, chimney-pieces of the time of Elizabeth and James I. are by no means uncommon; many are remaining not only in mansions of that period which are still kept up, but in houses which have been almost completely modernised in all other repects. A great number and also a great variety of them may be found in Nash's 'Old English Mansions,' and Richardson's different publications illustrative of Elizabethan architecture. In general they are exceedingly heavy and cumbrous in their mass, 'over-informed' with ornament of all sorts, in the style of the ponderous cabinets of the time, and showing in fact sometimes like immense pieces of furniture of the kind, owing to their rather contrasting than according with the enrichment bestowed on other parts of the room. Some however are of comparatively sober design, and even those which are most extravagant as compositions, and over-loaded with ill-assorted details, are of interest as exhibiting numerous samples of ornament.

As the more regular Italian style gained ground, the fashion of chimney-pieces greatly changed; the decorated superstructure reaching from the chimney-piece itself to the ceiling was either discarded altogether, or greatly reduced so as to become no more than a carved framing to a panel. The chimney-piece and fire-place were reduced to nearly their modern proportions and dimensions, whereas the opening or fire-place had previously been of such size that a person might stand within it, as it resembled that of a large open kitchen fire-place; which, putting aside other objections, caused a room to appear low by comparison. At present the *height* of the opening is made nearly the same in all cases, namely, from three to three feet and a half, the *width* alone being increased accordingly as a larger fire-place than usual is required, and the dressings around it extended so as to proportion the chimney-piece in some degree to the size of the room as a piece of architectural furniture in it: thus like other furniture its dimensions are limited by purpose and convenience, for were such as they dictate exceeded, the chimney-piece itself would look gigantic, and the mantel-piece would be out of reach. When therefore a single fire-place of the usual size is insufficient, as for very spacious rooms or galleries, there are two or even more according to circumstances, and they must of course be placed with strict regard to architectural symmetry: thus, if two, there is generally one at each end of the room, though both are sometimes placed on one side of it, namely, that facing the windows, equidistant from the centre, and if the room be an ante-room, with the door into it between them, and folding-doors at each end into the adjoining apartments. Again, if there are three chimney-pieces, one will be at each end, and the third in the centre of the side opposite the windows, though there are instances of even three being placed all on that side. More than that number are scarcely ever required,—even so many being rather for ornament and regularity of design than actual use. Apartments of such size as to require them on that account, are rarely used as ordinary sitting-rooms, and there is little occasion for fires in them at all when they are thronged with company. Still there is occasionally a greater number: the picture-gallery at Buckingham Palace, for instance, has no fewer than five chimney-pieces, namely, two on each side, and another at the north-end. Fire-places are sometimes made on the window side of the room, which although by no means to be recommended for general practice, or for more than one or two rooms at the most in the same house, has its advantages in particular cases. It is a convenient disposition for them in libraries, because a person can sit and read by the fireside and a window at the same time: it is also very agreeable to have a chimney-piece so placed when the windows command a fine prospect; thirdly, it produces a difference of character between that and the other rooms. In such case there must of course be a central pier for the fire-place, and that pier must be of such width as to allow the chimney-piece to be placed against it without seeming to be squeezed in between the windows. It is objected that when the chimney-piece is so placed, not only is the window side of the room apt to look crowded, but the opposite one to look blank; but that depends entirely upon circumstances: in a library, the opposite wall would be sufficiently filled with bookcases; or in any other room a sufficient balance may be kept up between the opposite sides by hanging some very large picture, or mirror, immediately facing the chimney-piece, or by a cabinet or some other large piece of furniture; or it may chance to be a very great convenience to have that side of the room free from a chimney-piece, as it affords the opportunity of obtaining spacious folding-doors in the centre of it into another apartment, or else a recess, either of which would sufficiently fill up that side of the room. Instead of being placed between windows, chimney-pieces are sometimes put *beneath* them, the mantel-piece forming the internal sill of the window, and the flue being carried up in one of the adjacent piers. Again, where fanciful effect is aimed at, a chimney-piece is set in an architectural compartment entirely filled with looking-glass, in which case the jambs and mantel-piece are made to project very considerably, so that, doubled by reflection, the chimney-piece has the appearance of being a solid and insulated mass of marble.

Marble is now the usual material for chimney-pieces even in ordinary houses, and such very general employment of it for the purpose has caused economy to be consulted by excessive plainness of design and scantiness of workmanship, sculpture being out of the question; the mouldings very few and plain, and the mantel-piece a mere shelf. Chimney-pieces of this class are manufactured by wholesale, and are kept like any other article of furniture ready-made, requiring only to be fixed when purchased. Convenient and economical as it may be, such a system is not calculated to advance taste, since a chimney-piece ought to be designed expressly for the particular room where it is to be put up. This is done of course in houses of a superior kind, and yet in some recent instances there is so far from being that accordance between the style of the chimney-pieces and the other architectural decorations of the room, that, although the former call for rather a greater than a lesser degree of embellishment, inasmuch as they are more closely observed, they have frequently very much less, consequently appear to be in a style of affected and harsh severity in comparison with all the rest. Worse than this, both style and keeping are sometimes so outrageously violated, that chimney-pieces of elaborate and frittered design, *à la Louis Quatorze*, are fixed in rooms whose other architectural dressings are marked by the opposite extreme of soberness or even plainness. Neither is that attention given to colour which ought to be: very dark or black marble is by no means the most suitable for such purpose, because instead of relieving the fire-place, the chimney-piece and fire-place together form a dull and sombre mass. This disagreeable effect is very greatly increased when—as is actually the case in the morning room of the Conservative Club-house—black marble chimney-pieces are introduced among scagliola columns and pilasters of pale or bright hues: all consistency of composition as to colour is destroyed, and instead of being ornamental objects, the chimney-pieces look no better than two dismal blots in the architecture. In fact black is quite as unsuitable a colour for chimney-pieces as it would be for door-cases and window-dressings. Among collections of designs for chimney-pieces, Piranesi's 'Maniere di ornar gli Camini' is unrivalled for magnificence of ideas.

CHIMNEY-SWEEPER, a person whose trade it is to cleanse foul chimneys from soot. The actual sweepers were formerly boys of very tender age, who were taught to climb the flues, and who, from the cruelties often practised upon them by their masters, became from the commencement of this century objects of the particular care of the legislature. The first and chief Act by which regulations concerning them

were enforced was the 28th Geo. III., c. 48. It was followed by the 4 & 5 Will. IV., c. 35. This Act expired in 1842, when the 3 & 4 Vict. c. 85, intituled 'an Act for the regulation of Chimney-sweepers and Chimneys,' came into effect. By this Act, the compelling or allowing a person under twenty-one years of age to ascend or descend a chimney, or to enter a flue for the purpose of sweeping it, or of extinguishing fire, is prohibited under a penalty of not more than 10*l*., or less than 5*l*. It is further provided by the same Act, that no child under sixteen years of age shall be apprenticed to a chimney-sweeper. This Act also contains regulations for the construction of chimneys. About the beginning of the present century, a number of public-spirited individuals joined in offering considerable premiums to any one who would invent a method of cleansing chimneys by mechanical means, so as to supersede the necessity of climbing-boys. Various inventions were in consequence produced. The principal parts of the one in general use are a brush and some hollow tubes which fasten into each other by means of brass sockets.

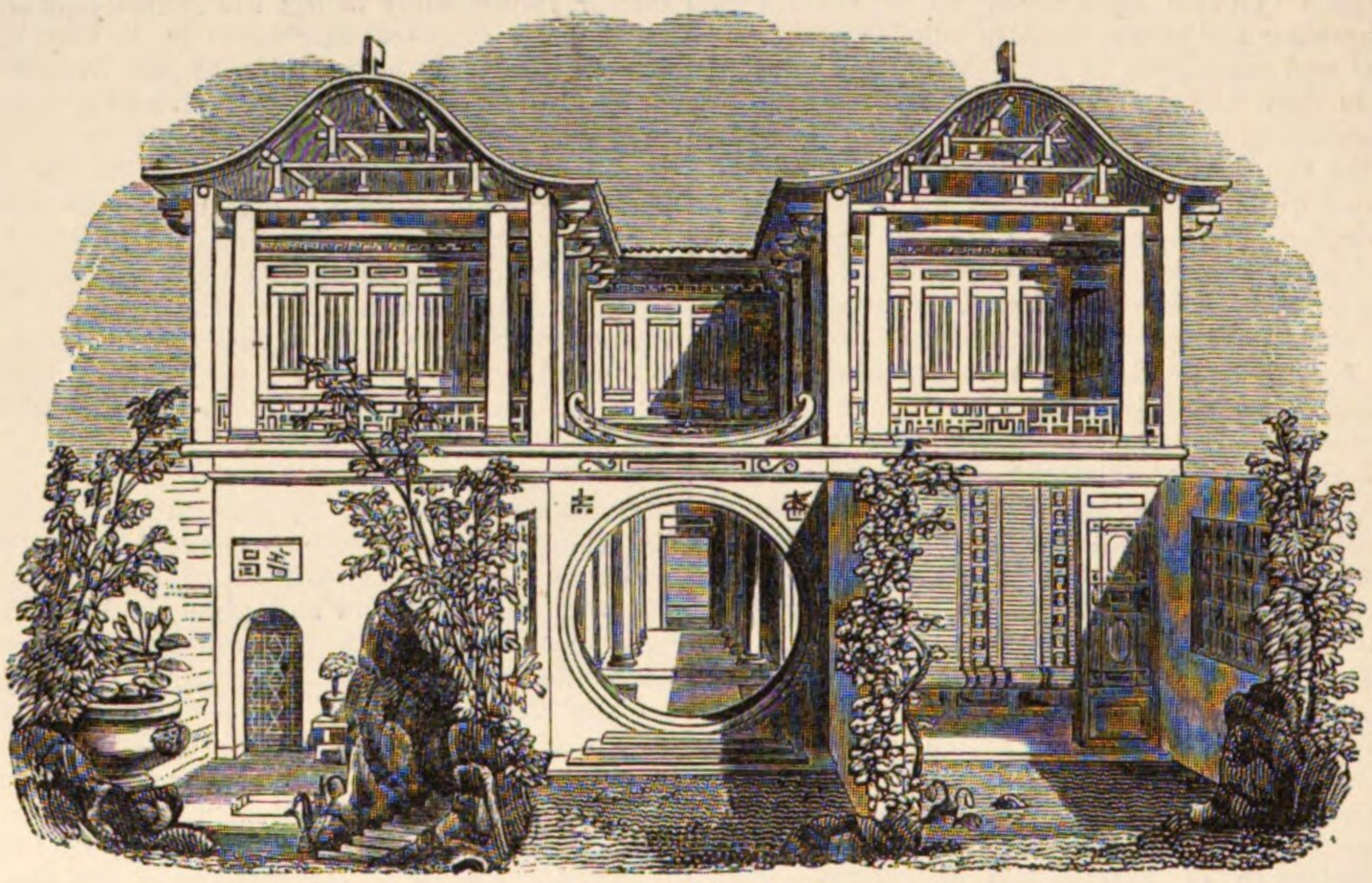
CHINA WARE. [PORCELAIN.]

CHINDEINE. [CINCHONA, ALKALOIDS OF.]

CHINESE ARCHITECTURE. The architecture of the Chinese may be considered unique in its style. Their buildings differ also in construction from those of Europe and the rest of Asia. The peculiar character of Chinese architecture is displayed in their royal palaces, temples, bridges, monumental arches, and also in their houses and sepulchres. The materials employed are wood, of which that most in use is the nan-mon, a kind of cedar, stone, marble, bricks, bamboo, and glazed or porcelain tiles. The construction of their dwelling-houses is directed by a public functionary, whom we may not inaptly designate a district surveyor. Every one is obliged to build his house according to his rank, and for every house a certain size and details are fixed. The ordinary habitations have only one floor. The houses called heon, that is of many floors, were once very much the fashion, and some were built above 200 feet high. Wooden columns, so placed

as to support the roof, are common, and are from eight to ten diameters in height. They are fixed on stone or marble bases, but have no capitals; an architrave of wood placed on the top of them runs through the wall of the house, and a beam which is carried through the upper part of the column, and passes through the wall also, is connected with the architrave on the outside of the house. The wooden pillars are always painted of a bright colour, commonly red, and varnished; the open work is usually green, and strong lines of blue, black, or gold relieve and give effect to the prevalent hues. The roofs are also covered, and the walls plastered with stained substances of brilliant colours. When fully painted, and decorated with their fanciful scroll-work and strange devices, the appearance of a Chinese house is singularly gay and brilliant. The roofs, which are slightly constructed of bamboo, are often double, and resemble one roof rising out of the other: they turn up at the eaves, at the angles of which are hung grotesque figures of dragons, &c. The framing of the roof, as will be seen by the cut, is quite different from the European method. Three or four transverse beams, placed one above another, serve as tie-beams, and by means of uprights the lower beam supports that above it, the lowest of all resting on the wooden columns already described. The construction is rude, but simple and effective; its character will be readily understood from the engraving. The columns and beams are often made of precious woods, and are inlaid with ivory, copper, and mother-of-pearl. Galleries or passages of intricate design abound, and are decorated in very pleasing taste with trellis-work and carving. Not the least singular appearance in a Chinese house is the door, which is often a complete circle; the window frames and sashes are formed of small pannels of various forms moulded out of clay, and neatly joined together. The sills of doors are of stone. The wood of the nan-mon is said by the Chinese to last more than a thousand years. Stone and marble, though in abundance, are more rarely used than wood, brick, and tile.

The palaces of the kings are built on large masses of alabaster as a

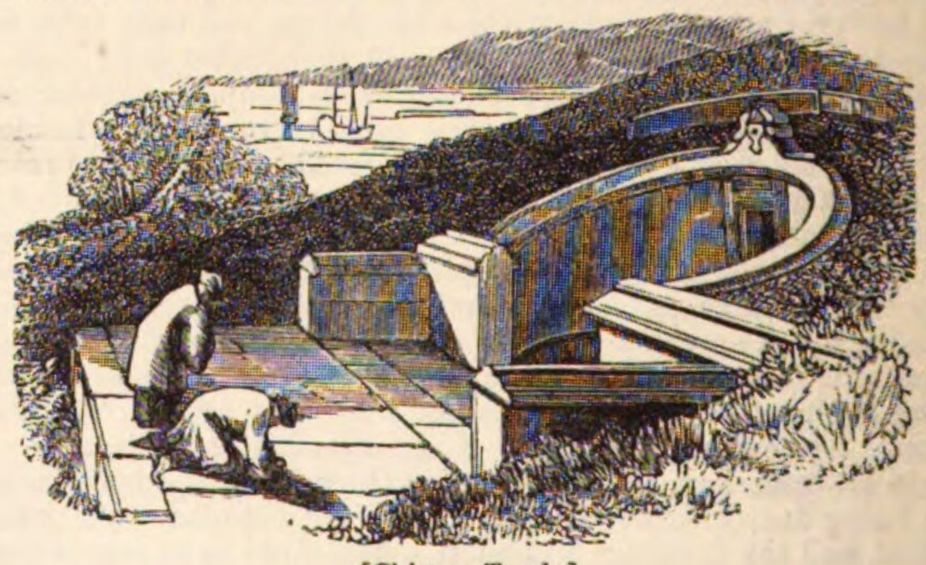


[Interior of Mansion.]

foundation. The palace of Pekin is on an immense scale, 2513 feet by 3235 feet. It is spoken of by the missionaries as presenting a very imposing appearance. The palace, which is divided into a number of courts, is composed of towers, galleries, porticoes, halls, and immense buildings: each court is more superb than the other as you approach towards the last court, the residence of the king, which is the richest of all.

The extraordinary respect paid by the Chinese to the dead has led them to the construction of rich and costly places of sepulture. Frequently the tomb is excavated out of the side of a hill, where a stone entrance structure in the shape of a horse-shoe, or rather a Greek Ω, is constructed, in a style that from its solidity and durability contrasts remarkably with the lightness and almost flimsiness of their dwelling-houses. These tombs are often constructed of granite, polished, and elaborately carved. But besides these there are tombs and monuments which exhibit a variety of architectural designs, often resembling the familiar forms of their buildings; even the double roof is carved on some mausoleums. The common people have only a cone of earth with trees on the summit, not unlike the barrows in Wiltshire. Several forms of tombs are given in Alexander's 'Costume of China.' The forms are round, square, hexagonal, and octagonal, and the form of the coffin is also imitated.

Another very remarkable kind of building is the *pae-low*, or honorary or monumental gateway (sometimes improperly called a triumphal arch), placed in the middle of streets, at the entrance of towns, and in front of temples, and even dwelling-houses of a superior grade. These arches are erected sometimes at the command of the emperor, and at the public expense, to commemorate the merits of some public functionary; but in other cases they are raised by private persons of

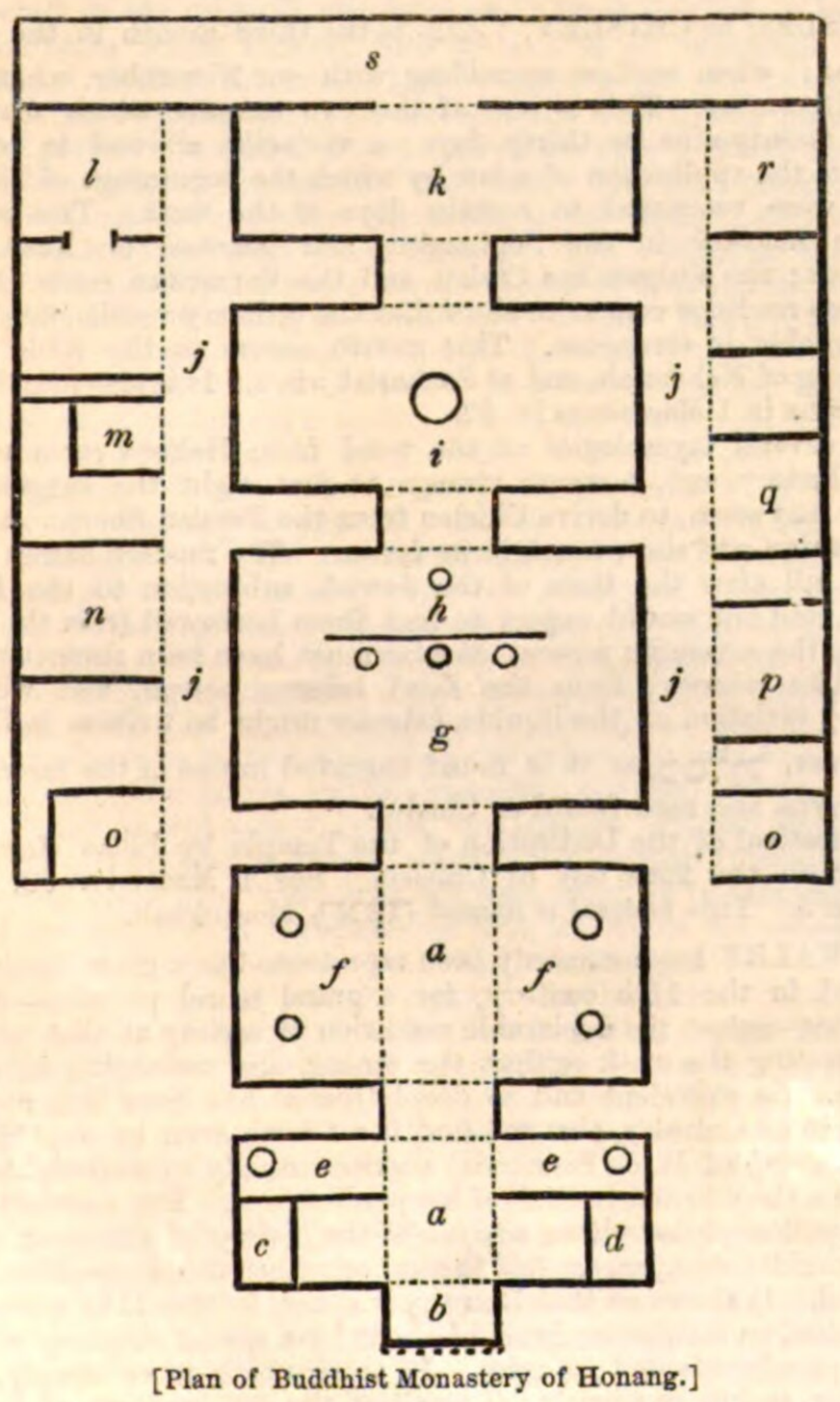


[Chinese Tomb.]

distinction, to the memory of a relative. In general character they resemble the domestic edifices; thin pillars supporting a roof or summit of somewhat elaborate character. They always have a broad and lofty central passage, with a narrower and usually a lower one on each side. Sometimes they are constructed of wood, brightly coloured

and richly gilt; at others they are built wholly of marble, or of stone. An inscription placed on a kind of frieze under the projecting roof, records the name and titles of the deceased, and the cause of the erection of the memorial. These arches are erected to the honour of women as well as men. In the smaller towns they are built of wood, and the workmanship of many is very coarse. One of the finest and most substantial is that which serves as the entrance to the city of Amoy. At Ming-po the arches have as usual three gates, two small and one large, the larger one being in the centre. The door-posts are of stone. The entablature consists of three or four faces, and the architrave is morticed and tenoned, although it is of stone. Mouldings are seldom used in these faces, except in the highest or the highest but one; instead of a cornice there is a projecting roof which crowns the whole. The ornaments of some of these arches consist of men, birds, and flowers, and the ground is cut away so that the day-light is seen behind: the three openings are also arched.

The temples though not differing very greatly in architectural character from the costlier domestic buildings, form, from their number and costliness, a very important feature in the architecture of China. Their number is enormous. In Pekin, and in the environs, there are said to be 10,000 temples: those which are within the walls of the palace are richly finished, and some are magnificent. To a great extent the temples differ in their plan. That of Honang, opposite Canton on the south, is enclosed within an oblong court, 590 feet by 250, which in the interior is surrounded by cells for the priests or bonzes. You enter the temple by an open vestibule, the ascent to which is by a step, and in which are two colossal statues mounted on huge granite pedestals. This vestibule leads to another, in which are four colossal seated figures, formed of stucco. This last vestibule leads into another great court surrounded with colonnades and rooms behind them for the priests. The court contains three square temples, equidistant, and set upon a plinth along the centre of the court. These buildings are each 33 feet square, and rise to a height of two stories, the lowermost of which is surrounded by a peristyle of 24 columns. They have the usual roof-like summit. The first of these courts contains the figures of the sacred Buddhist triad; in the second is a single figure of Omito Fo. The priests perform their religious ceremonies in these buildings. At the four corners of the court are other smaller and somewhat similar edifices but without columns, in which the chief priests reside. Under the colonnades and between the rooms of the ordinary priests, there are four chambers occupied by idols. Two smaller courts are placed on each side of the centre of the large court;



[Plan of Buddhist Monastery of Honang.]

these are surrounded by the kitchens, refectory, and hospitals; all the buildings are covered with green varnished tiles.

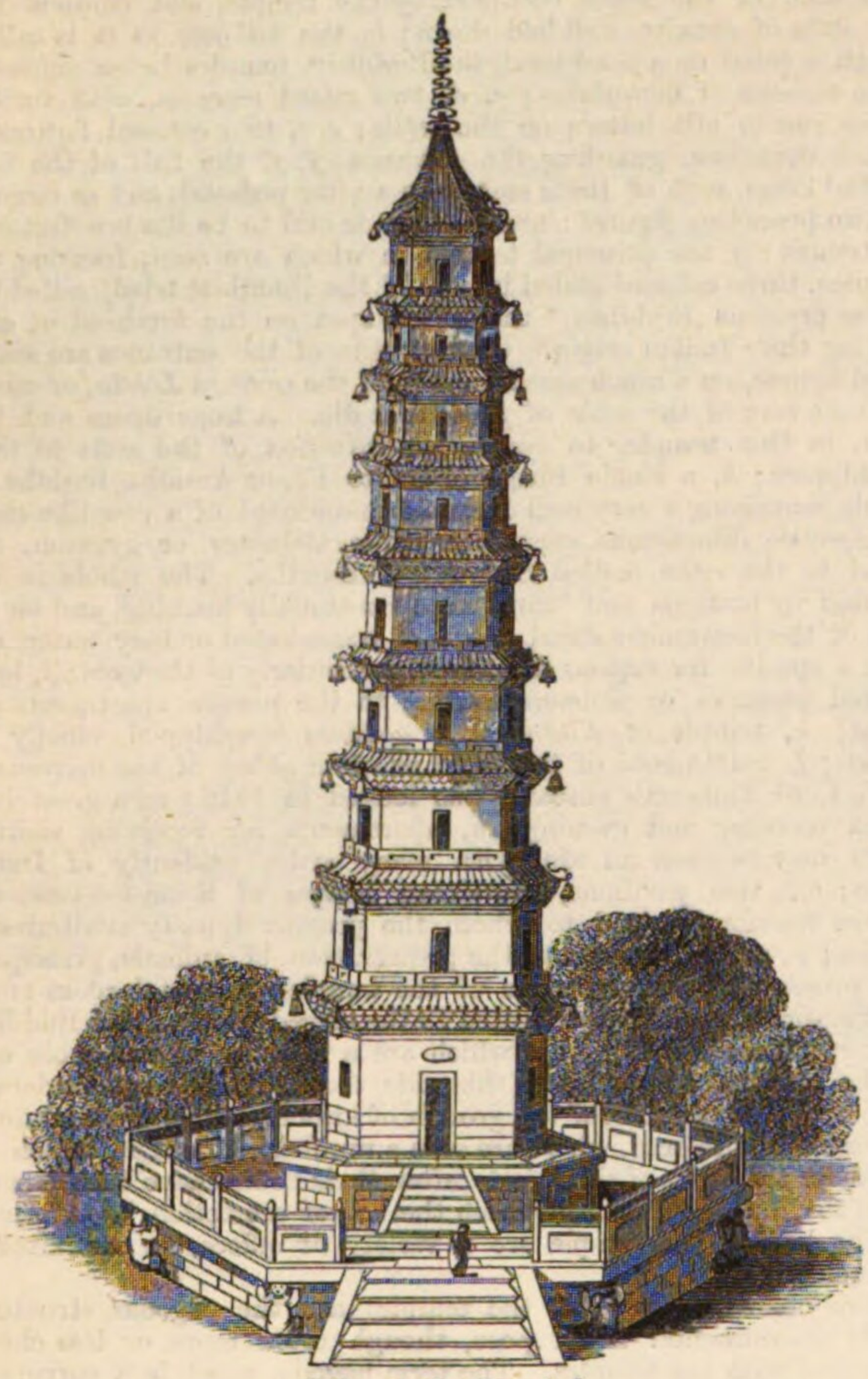
The annexed plan and more detailed description, from Davis's 'Chinese,' will, however, give a clearer view of this very remarkable structure, which may be taken as a type of its class.

a a is a handsome paved way, of considerable breadth, leading through the middle of the space occupied by the temple, and composed of large slabs of granite, well laid down; *b*, the *hill gate*, as it is called, though erected on a dead level, the Buddhist temples being generally in the recesses of mountains; *c*, *d*, two raised recesses, with various inscriptions in gilt letters on the walls; *e*, *e*, two colossal figures of gigantic divinities, guarding the entrance; *f*, *f*, the hall of the four celestial kings, each of them seated on a lofty pedestal, and as large as the two preceding figures: one of them is said to be the benefactor of the temple; *g*, the principal temple, in which are seen, fronting the entrance, three colossal gilded images of the Buddhist triad, called the "three precious Buddhas;" the round spot on the forehead of each marking their Indian origin. On each side of the entrance are seated gilded figures, on a much smaller scale, of the *eighteen Lohân*, or saints, who take care of the souls of those that die. A huge drum and bell serve, in this temple, to *awaken the attention* of the gods to their worshippers; *h*, a single image of Omito Fŏ, or Amidha Buddha; *i*, temple containing a very well executed monument of a vase-like shape and gigantic dimensions, carved in white alabaster, or gypsum, and sacred to the *relics* (called *Shay-ly*) of Buddha. The whole is surrounded by lanterns and lamps kept continually burning, and on the sides of the monument stand bowls of consecrated or holy water, said to be a specific for various disorders, particularly of the eyes; *j*, long, covered passages or cloisters, leading to the priests' apartments and offices; *k*, temple of *Kuân-yin*, a goddess worshipped chiefly by women; *l*, apartments of the chief priest or abbot of the monastery, where Lord Amherst's embassy was lodged in 1816; *m*, a great bell, struck morning and evening; *n*, apartments for receiving visitors, where may be seen an idol with many arms, evidently of Indian origin; *o*, *o*, two pavilions, containing images of Kuân-foo-tsze, and another warrior demigod, to whom the present dynasty attributes its success; *p*, a place devoted to the preservation of animals, principally pigs, presented by the votaries of the temple; *q*, a book-room and a printing-press, exclusively devoted to the sacred books of the Buddhist sect; *r*, a place for idols, near which are a number of miserable cells for the inferior priests; *s*, on this side there extends a considerable space of walled ground for the growth of kitchen herbs, and containing besides, a mausoleum, where are seen a number of jars, in which are deposited the ashes of the priests after their bodies have been burned. Here, too, is the building in which the act of cremation is performed. To the left of the temple are a variety of offices, as the kitchen, common room, &c., &c.

More characteristic than the temples are the pagodas, structures chiefly monumental in purpose, though often more or less closely connected with the temples. The term pagoda, which is a corruption of the Sanscrit *bhagavati*, "holy-house," is a name generally applied by Europeans to temples in the East, from China to Hindustan. The Chinese pagoda consists of several stories, usually nine, and generally comprises a porch, a vestibule or ante-sanctuary for the priests, and an inner sanctuary, containing the principal idol. Yet although called pagodas by Europeans, the name given by the Chinese themselves to such towers is *Taas*. They are very numerous throughout China. The most celebrated Taa is at Nankin. It is built of brick, but covered, both walls and roof, with plates of porcelain, and hence it is known as the Porcelain tower. Like most others, it is an octagon, with a diameter of about 42 feet, each face being 16 feet wide. It is upwards of 210 feet high, and is divided into nine stories, each of which has a marble gallery with gilt lattices, the stairs being formed within the thickness of the walls. From every story projects a kind of roof, at the angles of which bells are suspended. The summit is surmounted by a cupola, from which rises a lofty pole or mast about 30 feet high. When perfect, it is said to have had a very brilliant apppearance, but it has long been in a ruinous condition. Of that at Tong-Tschang-Fou, the exterior is also of porcelain, but the walls themselves are of marble. Others have a single staircase in the centre carried up through all the different stories. Although so completely dissimilar in style, these Taas bear a strong analogy to the lofty detached pyramid tower-temples of the Hindoos. [HINDOO ARCHITECTURE.] Both seem to have originated in a common idea, differently modified, according to the taste and mode of building of the respective nations. On the whole, the Chinese pagoda must be admitted to be a very effective object, especially in a distant view of a city. The pagoda at Kew, built by Sir William Chambers, is a very poor representation of a Chinese pagoda, having neither the colours nor brilliant decorations of the Chinese.

Most towns have extensive walls high enough to hide the buildings, except the pagodas or towers, and wide enough to ride on horseback. The walls of Pekin, which are built of brick, are 42 feet 6 inches high, and they have small square towers at every 200 feet. In some places there are long inclined planes for the cavalry to ascend. The isolated castle of Tien-sing-foo, at the confluence of the Pei-ho and Eu-ho rivers, is of a square form and built of slate-coloured bricks; the walls are ramped or inclined inwards; the basement is of stone, and the entrance, which is arched with stones, is at some height from the ground, with a square window on each side. The top of the castle has battlements, and below them is a large torus-moulding on a level with

the terrace; just above the torus are small semicircular arches to let the rain run off the terrace. The parapets between the battlements are each pierced with two small holes, and a small guard-house with the



[Nine-storied Pagoda.]

roof having the usual turned-up eaves is built on the top of the terrace. The Great Wall of China is described under CHINA [GEOG. DIV., vol. ii., cols. 467, 8]. Chinese bridges are noticed under BRIDGE.

CHININE. [CINCHONA, ALKALOIDS OF.]

CHINOIDINE. [CINCHONA, ALKALOIDS OF.]

CHINOLEINE. [CINCHONA, ALKALOIDS OF.]

CHINOVIC ACID. [QUINOVIC ACID.]

CHIOCOCCIC ACID. [QUINORATIC ACID.]

CHIRAYTA, the specific name, an imitation of the Sanskrit and Bengalee names, of a plant of the tribe of the Gentianeæ [AGATHOTES, in NAT. HIST. DIV.], and so greatly resembling a Gentian, that it is referred to that genus by Dr. Wallich, who has figured it in his 'Plantæ Asiaticæ Rariores,' vol. iii. p. 33, t. 252. It has not yet been received into the London Pharmacopœia, but has found a place only in that of Edinburgh; that it merits, however, a more extended use is certain. It is probable that even in India two distinct plants, both gentianaceous, are designated by the name Chirayta; at least Dr. F. Hamilton Buchanan found in Nepaul two so termed. The smaller of the two is that which is here treated of. Continental pharmacologists have had sometimes the one, sometimes the other, supplied to them. Hence very erroneous accounts are met with of the habitudes and physical characters of the Chirayta. Geiger describes it as a perennial plant, native of Egypt as well as of India, and of larger dimensions than the plant now intended. The genuine Chirayta is an annual plant, about three feet high, flowering in the rainy season. The whole plant is taken up, and the proper time for collecting it is just when the flowers begin to wither. When dried it has an intensely but agreeable bitter taste, and is destitute of aroma. The root is possessed of the greatest bitterness. The bitter principle is readily imparted to water and to alcohol. As it is not easy to ascertain what plant the Continental chemists analysed, it seems best to follow the analysis of Mr. Battley, whose specimens must have been genuine, having been furnished by Dr. Wallich. According to this chemist, it contains a free acid, a bitter resinous extractive, with much gum, and chlorates, with sulphates, of potash and lime. No alkaloid has been detected in it; what is therefore sold as a sulphate of chiraytine is well known to be only the disulphate of quinia. In regard to the pharmaceutical preparations of chirayta, infusion and watery extract, or a tincture of it, are alone to be recommended. Not only is the decoction a most improper form, but an infusion made with warm water is to be condemned, as this causes most distressing headache. Even to form the cold infusion a pint of water should not stand more than twenty minutes on half an ounce of the bruised plant. The tincture is a grateful addition to it.

Chirayta possesses the general properties of bitter tonics; but has at the same time some peculiar to itself, which fit it well for certain forms and complications of disease. Unlike most other tonics, it does not constipate the bowels, but tends to produce a regular action of the alimentary canal, even in those subject to habitual constipation. During its use, the bile becomes more abundant and healthy in character. The tendency to excess of acidity in the stomach, with disengagement of flatus, is much restrained by its use. These qualities fit it in a most peculiar degree for the kind of indigestion which occurs in gouty persons. It may, when necessary, be associated with alkaline preparations, or with acids; the latter are generally preferable. The same remark applies to its employment in the treatment of scrofula, in which alkalies are so freely and often injuriously employed. As a remedy against the languor and debility which affect many persons in summer and autumn, nothing is equal to the cold infusion of this plant. It may be taken twice or even more frequently daily, for a considerable time; then discontinued, and afterwards resumed. Children take it more readily than most other bitters. It is found to be a very efficacious remedy in India against intermittents, particularly when associated with the Guilandina Bonduc, or Caranga nuts. The debility which is apt to end in dropsy is often speedily removed by infusion of Chirayta; to which is added the tincture formed of it with orange-peel and cardamoms. Its efficacy in worm-cases has procured for it the name of *worm-seed* plant. The extract is given with great benefit in some forms of diarrhœa and dysentery, particularly if combined with ipecacuan, the emetic tendency of which it very markedly controls.

It is unnecessary to enter here into a review of the arguments adduced by Fee ('Cours d'Histoire Naturelle Pharm.' ii. p. 395) and Dr. Royle ('Flora of the Himalayas,' p. 277), to disprove the notion of Guibourt that this was the *Calamus verus* of the ancients. The calamus was more probably a grass, possibly that which in the present day is said to yield the *grass-oil* of Namur. Whencesoever obtained, this oil possesses great virtues. It is much used in India against rheumatism. It has the power in a most remarkable degree of preventing the hair of the head from falling off after acute diseases, such as fevers, or after confinements or prolonged nursing. It even restores it after it has fallen off. But it must be strong and pure; not the diluted feeble oil sold by perfumers under the name of oil of grass.

CHISLEU or CHISLEV, כִּסְלֵו, is the third month in the Jewish calendar; when earliest coinciding with our November, when latest with December. This is one of the two months which may have either twenty-nine or thirty days; a variation allowed in order to admit of the application of a law by which the beginnings of Tisri and Nisan were restricted to certain days of the week. The word is written Χασελεῦ in the Septuagint, and Χασλεῦ, or Χασλὲβ, by Josephus; the Vulgate has Casleu, and the Samaritan reads Chaslim. All these readings concur to show that the ordinary vocalisation of the first syllable is erroneous. This month occurs in the Bible at the beginning of Nehemiah, and at Zachariah vii. 1. It is also found in the Apocrypha in 1 Maccabees iv. 52.

The several etymologies of the word from Hebrew roots are very unsatisfactory, and, however strange at first sight the suggestion of Benfey may seem, to derive Chisleu from the Persian Sheriur, a nearer examination will show much in its favour. The modern names do not appear till after the time of the Jewish subjection to the Persian empire, and one would expect to find them borrowed from the names used by the sovereign power; *Sheriur* must have been anciently something like *ksheriur*, from the Zend *kshatra vairya*, and with the ordinary variation of the liquids, *ksheriur* might be written in Hebrew characters, כסליול, as it is found engraved in one of the inscriptions at Palmyra, and read Caslul or Chislul.

The festival of the Dedication of the Temple by Judas Maccabæus is kept on the 25th day of Chisleu. See 1 Macc. iv. 52, and 2 Macc. x. 5. This festival is named חֲנֻכָּה, khanukkah.

CHIVALRY has commonly been represented as a great institution, invented in the 11th century, for a grand moral purpose—that of struggling against the deplorable condition of society at that period—of protecting the weak against the strong, and redressing individual injuries. So prevalent and so deeply rooted has been this notion of the origin of Chivalry, that we find it set forth even in the 'Histoire des Français' of M. de Sismondi, a writer usually so clear-sighted and so little a slave to the routine of his predecessors. But a closely attentive as well as philosophical analysis of the history of European society in the middle ages, proves this theory, or rather this supposition, to be deceitful. It shows us that Chivalry was not, in the 11th century, an innovation, an institution brought about by a special exigency which it was expressly adapted to meet. It arose much more simply, more naturally, and more silently; it was but the development of material facts long before existing—the spontaneous result of the Germanic manners and the feudal relations. It took its birth in the interior of the feudal mansions, without any set purpose beyond that of declaring,

first, the admission of the young man to the rank and occupation of the warrior; secondly, the tie which bound him to his feudal superior —his lord, who conferred upon him the arms of knighthood.

Of this we find an irrefragable proof in history of the term *miles* itself, which was constantly used in the latinity of the middle ages to designate the chevalier, or knight. Towards the end of the Roman empire, the verb *militare* signified simply to serve, to discharge some service towards a superior, whether the service itself were of a military or a civil nature. The service originally denoted by this expression, indeed, was, no doubt, the military service exclusively; but the use of the term had in course of time been extended until it embraced every subordinate office and function. After the Germanic invasions of the declining Roman empire, we find it frequently employed in speaking of the household of the barbarian kings, and the offices which their companions held about their persons. Soon, by a natural retrogression, in conformity with the new turn given to the social state, the term *miles* resumed its almost exclusively warlike character, and denoted the companion, faithful to the service of his superior. It thus became synonymous with *vassus*, or *vassallus*, and indicated that a certain man held of another a *beneficium*, or fee, and was attached to him by that consideration; in short, from the 9th to the 12th century, the word *miles* denoted, not the chevalier, or knight, as ordinarily conceived of, and as M. de Sismondi himself has described him, but simply the companion, the vassal, of a feudal superior.

Here we see the true and necessary origin of chivalry. But in the course of its development, when once the feudal society had acquired some degree of stability and self-confidence, the usages, the feelings, the circumstances of every kind, which attended the young man's admission among the vassal warriors, came under two influences which soon gave them a fresh direction, and impressed them with a novel character. Religion and imagination, poetry and the Church, laid hold on chivalry, and used it as a powerful means of attaining the object they had in view, of meeting the moral wants which it was their business to provide for. So early as the 9th century we find some religious ceremonies associated with the Germanic practices on these occasions. A succinct account of the reception of a chevalier, as practised in the 12th century, will show what progress this combination had made, and how powerfully the Church had laid its grasp on every particular of of that solemn act of the feudal life.

The young man, the squire, aspiring to knighthood, was first of all stripped of his garments and put into a bath, the symbol of purification. On his coming out of the bath, they clad him in a white tunic, the symbol of purity, a red robe, emblematic of the blood which he was to shed in the cause of the faith, and a black doublet, in token of the dissolution which awaited him as well as all mankind. Thus purified and clothed, the novice kept a rigorous fast for twenty-four hours. When evening came, he entered the church, and passed the night in prayer, sometimes alone, sometimes with a priest and with sponsors who prayed in company with him. The next morning, his first act was confession; after which the priest administered to him the communion; and after communion he heard a mass of the Holy Ghost, and commonly a sermon on the duties of a chevalier, and the new course of life on which he was about to enter. When the sermon was over, the novice advanced towards the altar, with the sword of knighthood suspended from his neck: the priest took it off, blessed it, and attached it to his neck again. The novice then went and knelt before the lord who was to knight him. "To what end," the lord then asked him, "do you desire to enter into this order? If it is that you may be rich, repose yourself, and be honoured without doing honour to knighthood, then you are unworthy of it, and would be to knighthood you should receive, what the simoniacal clergyman is to the prelacy." And on the young man's answering that he promised well to discharge the duties of a knight, the lord granted his request.

Then did knights in attendance, and sometimes ladies, approach the novice, and array him in his novel garb, putting on first the spurs, next the hauberk or coat of mail, then the cuirass or breast-plate, then the brassarts or arm-pieces, and the gauntlets, and lastly girding on the sword. Then he was *dubbed*, to use the modern English expression, derived from the French *adoubé*, which, according to Ducange, signified *adopted*. The lord rose from his seat, went up to him, and gave him the *accolade*, that is, three strokes with the flat of his sword upon the shoulder or the nape of the neck, and sometimes a blow with the palm of his hand upon the cheek, saying, "In the name of God, Saint Michael, and Saint George, I make thee a knight;" and sometimes adding, "Be thou brave, bold, and loyal." The young man being thus knighted, they handed him his helmet, and brought him a horse upon which he sprang, usually without the aid of the stirrup, and caracoled within the church, brandishing his lance and flourishing his sword. Then quitting the church, he went and exhibited himself in like manner in public, beneath the castle walls, before the populace, whom he found eagerly awaiting their share of the spectacle.

It is easy to recognise in all this the influence of the priesthood, studious to associate religion with every circumstance of a solemnity so important in the warrior's life. Not only have the Christian sacraments their place in the ceremonial, but several of the observances more peculiarly chivalric, are assimilated as much as possible to the administration of a sacrament. Such was the share taken by the ecclesiastical order in what may be called the exterior material part of

the reception of a knight. And when we look into the moral character of chivalry, when we examine the series of oaths required of the knights at various periods from the 11th to the 14th century, and mark the ideas and the feelings with which it was sought to imbue them, we find the clerical influence no less distinctly apparent; and, indeed, a part of the oath was, that the knight should defend the rights of holy church, and respect religious persons and institutions. Certain it is, that in the obligations thus imposed upon the chevalier, we find a moral development extremely foreign to the state of lay society at that period. Moral notions so exalted—often so delicately scrupulous—above all, so humane, and so constantly impressed with the religious character, evidently emanated from the clergy. They alone then viewed the duties and relations of men in such a light; and their influence, it must be owned, was constantly employed in directing towards the fulfilment of those duties, and the improvement of those relations, the ideas and the usages to which chivalry had given birth. Whatever evils resulted from the unscrupulous and improvident use which the Roman Church made of this direct influence over the power of the sword, in promoting so many crusades against the infidel and the schismatic, it undeniably made use of the chivalric institutions which feudalism had brought forth, in labouring to introduce internal peace in society, and a stricter and more comprehensive morality into individual conduct.

In proportion as this endeavour succeeded, and as chivalry more and more appeared under a character at once warlike, religious and moral, at once conformable and superior to the actual manners, it seized upon and inflamed the imaginations of men; and in like manner as it had intimately bound itself up with their belief, so also it became the ideal standard of their aspirations, and the source of their most exalted pleasures. Poetry, in short, laid hold on chivalry as religion had already done. As early as the 11th century, the chivalric ceremonies, duties, and adventures, formed the mine to which the poets resorted for the means of charming the people, of at once gratifying and stimulating that craving of the imagination, that thirst for incidents more varied and more stirring, for emotions purer and more elevated, than real life affords. For it should be observed, that in the earlier stages of society poetry is not merely a national pastime; it is also a means of progress, exalting and developing man's moral nature. The poetical remains that have descended to us from that age show, that the poet imposed upon the chevalier the fulfilment of the same duties, and the practice of the same virtues, as were inculcated in the more solemn exhortations of the priest.

It is an oft-repeated observation, that all this was mere poetry, a fine chimæra, bearing no resemblance whatever to the reality. And indeed, when we consider the state of manners in those three centuries, and the incidents of daily occurrence that filled the lives of men, the contrast between the duties and the actions of the chevaliers is truly shocking. The period before us is undoubtedly one of the most grossly brutal in the history of European society, one in which we find the greatest amount of crime and violence, in which the public peace was most incessantly disturbed, in which the most dissolute manners prevailed. To any one attending only to the positive and practical state of society, all this poetry and morality of chivalry looks like sheer falsehood. Yet it is undeniable that the chivalric morality and poetry existed simultaneously with these disorders, with this barbarism, with all this deplorable social state. The monuments are before us: the contrast, we repeat, is shocking, but it is real.

This very contrast, however, forms the great distinctive characteristic of the middle ages. When we look into other social systems, as the Greek and Roman, when we examine, for instance, the early stage of Greek society, its heroic age, of which the poems that bear the name of Homer present a faithful mirror, we there find nothing resembling the contradiction that strikes us in the middle ages. The practice and the theory of manners are there nearly accordant. We do not find men having ideas much purer, nobler, and more generous than their daily acts. Homer's heroes seem quite unconscious of their own brutality, ferocity, selfishness, and covetousness; their moral science is no better than their conduct; their principles are on a level with their acts. We find it to have been the same with all other social systems in their vigorous and turbulent youth. But in Europe, on the contrary, in the middle ages, while the deeds are habitually detestable, while crimes and disorders of every description abound, yet we find dwelling in the minds and imaginations of men nobler instincts and more exalted aspirations. Their notions of virtue are much more developed; their ideas of justice incomparably better than what is practised around them, than what they practise themselves. A brighter ideal of morality hovers, as it were, above that rude and stormy social state, attracting the view and commanding the respect of men whose lives are little conformable to it. Christianity must undoubtedly be ranked among the principal causes of this fact; for its great characteristic is, its labouring to inspire men with a high moral ambition, to keep constantly before their eyes a standard infinitely superior to human reality, and stimulate them to attain it. But whatever be the cause, the fact is indubitable. We find it everywhere in the middle ages, in the popular poetry as well as in the exhortations of the priests. The moral conceptions of men rose far above the practice of their lives. Nor let it be thought, because those conceptions did not govern their actions, because their practice so strangely belied their

theory, that the influence of the theory was absolutely null. The habitual judgment of men upon human actions is not without its effect. It has been justly remarked, that a bad action is better than a bad principle: a bad action may remain isolated and solitary; but a bad principle is constantly fructifying; for after all, it is the mind that governs; and a man acts from reflection much oftener than he is himself aware of. In the age of chivalry, we repeat, the principles were infinitely better than the acts. For instance, at no period perhaps has the intercourse between the sexes been more licentious; yet never was purity of manners more strongly enjoined or more feelingly described; and perhaps the fantastic elevation given to the female sex by the laws of chivalry, may have tended ultimately to place woman in her true position as the equal companion of man. Nor was purity of manners a theme for poetic eulogy alone. We find from a multitude of testimonies that the public thought in this particular as the poet spoke, that the prevailing moral notions were pure and noble amidst all the rudeness and licentiousness of conduct.

This, then, was the grand moral characteristic of chivalry, which entitles it to an important place in the history of modern civilisation. If, on the other hand, we regard it not in a moral but in a social point of view, not as an idea but as an institution, it merits but slight consideration; for though it had a great and stirring part in the world's affairs, yet, as already shown, it did not constitute an actual specific institution at all. The feudal lords, the possessors of fiefs, were alone chevaliers; they alone, with few exceptions, had the right to become so. The knights formed no separate class of society with distinct functions and duties. Thus chivalry, properly so called, being inseparably bound up with feudality, could not survive its extinction; and accordingly, so early as the 14th century, when compared with its condition in the 12th, we find it rapidly declining.

It had, however, given birth to the religious orders, as the Templars, the knights of St. John, and the Teutonic knights; and it was beginning to produce the courtly orders—those of garters and ribbons—the knighthood of mere rank and parade. It was destined to tincture yet a long while the manners, the language, and the literature of European society. But the true chivalry, that to which alone the name can strictly be applied, flourished and fell with feudalism.

CHLOCARBETHAMIDE. *Chloracetamide. Trichloracetamide* ($NH_2(C_4Cl_3O_2)$). One of the chlorinated derivatives of acetamide. [AMIDES.]

CHLONAPHTASE ($C_{20}H_7Cl$). One of the numerous series of substitution products obtained by Laurent from naphthaline ($C_{20}H_8$). For further details respecting these bodies, see Miller's 'Elements of Chemistry,' vol. iii. p. 577.

CHLOR—CHLORO. Prefixes applied to designate a very large number of substances, chiefly organic, containing chlorine. The great majority of these bodies constitute what are termed *substitution* products, which are produced by the substitution of a certain number of atoms of chlorine for the same number of atoms of hydrogen in an organic body. Thus chloracetic acid ($C_4ClH_2O_4,HO$) is acetic acid in which one atom of hydrogen has been replaced by one of chlorine. Some of these substitution products are described under their respective names, the rest, if of any importance, are mentioned under the name of the substance from which the derived name has been formed, by the addition of one of the above prefixes. Thus *Chloraniline* will be found under ANILINE. *Chlorobenzoic Acid* under BENZOIC ACID, &c.

CHLORACETAMIC ACID, *Quadrichloracetamide* [$NHCl(C_4Cl_3O_2)$], one of the chlorine substitution products derived from *acetamide*.

CHLORACETAMIDE. [CHLOCARBETHAMIDE.]

CHLORACETHYPHIDE, another name for *phosphide of trichloracetyl*, or, as it might be more appropriately called, *trichloracetphosphamide* $\left(P\left\{\begin{matrix}C_4Cl_3O_2\\H\\H\end{matrix}\right.\right)$. [AMIDES.]

CHLORACETIC ACID ($C_4H_2ClO_3$, HO), a substitution acid obtained by exposing acetic acid diluted with half an atom of water to dry chlorine, in the shade. If the action takes place in sun-light, *trichloracetic acid* is produced. Chloracetic acid closely resembles acetic acid in its appearance and properties, and it is only of interest as showing that the hydrogen of negative organic bodies may be replaced by chlorine with scarcely any sensible alteration in properties.

CHLORAL, *Trichloraldehyde, Trichlorinated hydride of Othyl* ($C_4Cl_3O_2H$), a liquid prepared by Liebig with chlorine and alcohol, from the first syllables of which words its name is derived. To form it, a current of dry chlorine gas is passed into anhydrous alcohol, at first kept cool, but afterwards sufficiently heated to expel the hydrochloric acid formed. During the action of these substances one portion of the chlorine unites with the hydrogen of the alcohol to form hydrochloric acid, and another portion with its oxygen and carbon to constitute chloral. When the operation has been long continued, a liquid of the consistence of a syrup is procured, which afterwards becomes solid; it is a hydrate of chloral containing some undecomposed alcohol and a portion of hydrochloric acid. It is then to be shaken with concentrated sulphuric acid, which combines with the water, and the chloral rises in a fluid state to the surface; this is to be mixed with lime, and by distillation the chloral is obtained free from hydrochloric acid.

Chloral is a colourless transparent oily-looking fluid; its smell is pungent, and its taste but slight; its specific gravity is 1·502; at about 200° Fahr. it boils,and the vapour condenses unchanged. Water when warmed dissolves chloral, but when mixed with a small quantity of it, they combine, when agitated, into a solid crystalline hydrate. By alcoholic solution of potash or soda it is decomposed, formiate of potash and chloroform being produced. [OTHYL, HYDRIDE OF].

CHLORALBIN ($C_{12}H_6Cl_2$). A chlorinated derivative of carbolic acid.

CHLORALIDE ($C_{12}H_6Cl_7O_8$?). An unimportant product of the decomposition of CHLORAL.

CHLORALÖIL ($C_{13}ClO_5$?). A product of the action of chlorine upon the juice of the aloe.

CHLORAMILAL ($C_{10}H_8Cl_2O_2$?). A liquid product of the action of chlorine upon amylic alcohol. It appears to stand in the same relation to amylic alcohol as chloral does to vinic alcohol. [CHLORAL.]

CHLORANIL. [QUINONE, PERCHLORINATED QUINONE.]

CHLORANILAM. [QUINONIC ACID].

CHLORANILAMIC ACID. [QUINONIC ACID.]

CHLORANILAMIDE. [QUINONIC ACID.]

CHLORANILAMMON. [QUINONIC ACID.]

CHLORATES. [CHLORINE; CHLORIC ACID.]

CHLORAZOL ($C_8H_8Cl_3N_2O_8$?), a very poisonous acid liquid, obtained by the action of nitrohydrochloric acid upon albumen. It possesses a very penetrating odour, is insoluble in water, but soluble in alcohol, and has a specific gravity of 1·555.

CHLORAZOSUCCIC ACID. [SUCCINIC ACID.]

CHLORELAYL-HYPOSULPHURIC ACID. [CHLOROMETHYL-SULPHUROUS ACID.]

CHLORETHERAL. [ETHER.]

CHLOREXTHOSE, *Oxide of perchlorobrominated ethyl* ($C_8Cl_6Br_4O_2$) [ETHER.]

CHLORHYDRIC ACID. [CHLORINE; HYDROCHLORIC ACID.]

CHLORHYDRIN, or *Hydrochlorate of Glycerin*, less water. According to M. Berthelot, three chlorhydrins exist:—

Monochlorhydrin . .	$C_6H_7ClO_4 = HCl + C_6H_8O_6 - 2HO$
Dichlorhydrin . . .	$C_6H_6Cl_2O_2 = 2HCl + C_6H_8O_6 - 4HO$
Epichlorhydrin . . .	$C_6H_5ClO_2 = HCl + C_6H_8O_6 - 4HO$

Monochlorhydrin is obtained by saturating glycerin with hydrochloric acid gas and maintaining the mixture at the temperature of boiling water for thirty-six hours. Saturation with carbonate of potash, agitation with ether, and evaporation of the ethereal solution, will yield a product that by distillation at a temperature of 440° Fahr. furnishes nearly pure monochlorhydrin. It may be quite purified by treating with lime and ether.

This substance is a neutral oil, of a cooling ethereal odour and a sweetish taste, becoming after a time pungent. It is miscible with water and ether. It burns with a white flame bordered with green, and gives off hydrochloric acid. It is slowly and with difficulty saponified by oxide of lead, glycerin being set free. It remains fluid at 35° below the zero of Fahrenheit's thermometer.

Dichlorhydrin is prepared by dissolving glycerin in twelve or fourteen times its weight of fuming hydrochloric acid, and subjecting the mixture to a temperature of 212° Fahr. for eight hours. It is purified in the same way as monochlorhydrin.

Dichlorhydrin is also a neutral oil, of decided ethereal odour. Its density is 1·37. Boiling point, 352° Fahr. In other respects it much resembles monochlorhydrin.

Epichlorhydrin is formed when dichlorhydrin is exposed for many hours in hermetically sealed vessels, filled with hydrochloric gas, to a temperature of 212° Fahr., or when dichlorhydrin is heated for some time with large excess of fuming hydrochloric acid. It is purified in the same manner as the other chlorhydrins. Its odour resembles chloride of ethyl, but is more persistent. Its specific gravity is between 1·2 and 1·3. Boiling point, between 248° Fahr. and 266° Fahr. Its chemical composition is indicated above.

CHLORHYDROPHENIDE. [PHENYL, CHLORIDE OF.]

CHLORHYDROPROTEIC ACID. The precipitate produced by hydrochloric acid in a solution of albumen is regarded by Mulder as a peculiar acid to which he has given this name. It contains 3·7 per cent. of hydrochloric acid.

CHLORIC ACID. [CHLORINE.]

CHLORIDES. Compounds of chlorine with other elements. The compounds with non-metallic bodies will be found under CHLORINE, and those with metals under the names of the respective metals; thus chloride of manganese will be found under MANGANESE, &c.

CHLORIMETRY (*Chlorometry*). The measuring of the amount of chlorine available for bleaching or disinfecting purposes in any compound in which it is contained.

The estimation of the commercial value of a sample of bleaching powder (chloride of lime) [CALCIUM, *Chlorine and*], is most conveniently performed by the process known as *Dalton's test*. This operation is based on three chemical facts: first, protoxide of iron is converted into peroxide of iron by the action of free or loosely combined chlorine; second, the amount of chlorine necessary to effect this action on a given weight of protoxide of iron is always the same; third, red prussiate of potash (ferricyanide of potassium) gives with protosalts of iron a blue precipitate, with persalts of iron no precipitate; this last enables the experimenter to ascertain when the action is complete.

It follows, therefore, that as we know what amount of chlorine is

necessary to convert a given weight of protosalt of iron into persalt of iron, it is only necessary to add our solution of bleaching powder of unknown strength to that given weight of protosalt of iron, till it ceases to yield a blue precipitate with red prussiate of potash, when the amount of chlorine in the quantity of bleaching solution we have used is at once indicated; and if we have made that solution with a weighed quantity of bleaching-powder, the strength, and therefore the commercial value of that powder is, by a very simple calculation, readily ascertained. The following are the details of this process :—

78·1 grains of pure, dry, recently-prepared protosulphate of iron (green vitriol) are dissolved in about two ounces of water, and a little sulphuric or hydrochloric acid added; to convert this into persulphate of iron, ten grains of chlorine are necessary. Fifty grains of the sample of bleaching-powder are rubbed in a mortar with a little water, and the mixture introduced into such a burette as under the article ALKALIMETRY is designated an alkalimeter; the mortar is washed with a little more water, and the liquid added to that already in the burette, which is then filled up to 0, and the orifices being closed by the finger and thumb, thorough mixture is promoted by agitation; each division marked on the burette will now contain half a grain of bleaching-powder. To the solution of protosulphate of iron, placed for convenience, and to ensure accuracy, in a stoppered bottle of about six ounces capacity, is added the bleaching solution from the burette, till, after agitation, a drop placed on a white plate gives no blue precipitate, but only a slight green colouration, when a drop of solution of red prussiate of potash is added to it. The number of burette divisions of bleaching solution used will obviously contain ten grains of chlorine; and, as each division contains half a grain of bleaching-powder, the whole number used in the experiment, divided by two, indicates the number of grains of chloride of lime that contain ten grains of chlorine. A short calculation gives the amount of available chlorine in 100 grains of the sample of chloride of lime subjected to analysis. Let m represent the number of measures used, then

$$\frac{m}{2} : 10 :: 100 : x$$

x will be the percentage of available chlorine.

The reaction that takes place will at once be seen by a glance at the following equation :—

$$\underbrace{2(FeO, SO_3)}_{\text{Protosulphate of iron.}} + \underbrace{2(HO, SO_3)}_{\text{Sulphuric acid.}} + \underbrace{CaO, Cl}_{\text{Chloride of lime.}} = \underbrace{Fe_2O_3, 3SO_3}_{\text{Persulphate of iron.}} + \underbrace{HCl}_{\text{Hydrochloric acid.}} + \underbrace{CaO, SO_3}_{\text{Sulphate of lime.}} + \underbrace{HO}_{\text{Water.}}$$

Two other chlorimetrical processes have been proposed, both similar in principle, but not generally superior, to the one just described. In one, arsenious acid (AsO_3) is used in the place of the protosulphate of iron; the chlorine converts it into arsenic acid (AsO_5). In the other, yellow prussiate of potash (ferrocyanide of potassium) is the agent employed to absorb the chlorine; from every two equivalents of it ($2K_2Cfy = K_4Cfy_2$), one equivalent of chlorine abstracts one equivalent of potassium, forming chloride of potassium, leaving an equivalent of the red prussiate of potash (ferrocyanide of potassium = K_3Cfy_2). The arsenious acid process is known to be complete when a few drops of indigo solution, with which the mixture is tinted, are decolorised; the prussiate process is known to be complete when the mixture no longer gives a blue precipitate with a persalt of iron.

Chlorimetry is almost an hourly operation with the calico bleachers, inasmuch as the dilute solution of chloride of lime contained in their steeping vessels is, of course, much weakened by the immersion of a large quantity of unbleached goods; and the strength of the weakened solution requires to be known, in order that the proper quantity of the strong stock solution of chloride of lime may be added to restore the bath to its original strength. This is the more important on account of the limited range of strength of the steeping liquor, within which the cotton is properly bleached: if too strong, the goods are injured; if too weak, the fabric still remains brown. It is, therefore, very necessary that the calico-bleachers should possess a chlorimetric process that can be quickly, as well as accurately performed; and for this reason they usually adopt the method known as—

Crum's process. This test is based on the same principles as Dalton's test, namely, that chlorine converts a protosalt of iron into a persalt, and that a given quantity of the protosalt always requires the same amount of chlorine for its conversion; but the colour of a constant volume of the bleaching solution containing excess of protosalt of iron is made use of to determine the amount of persalt of iron in it; the intensity of this colour is obviously in direct proportion to the quantity of available chlorine in the volume of bleaching solution used. The following are the details of this operation :—

The protosalt of iron used is the protochloride, and is made by digesting excess of cast-iron turnings in hydrochloric acid, diluted with about half its bulk of water, at the temperature of boiling water, till all action has ceased. When cold, this solution is diluted till it has a specific gravity of 1·200, equal to 40 degrees on the scale of Twaddell's hydrometer, the instrument usually adopted by manufacturers for taking specific gravities. This liquid, mixed with acetic acid of sp. gr. 1·048, forms the proof solution. Diluted with water, it is colourless, but the addition of chlorine gives rise to the formation of peracetate of iron, which has a peculiarly intense red colour. A quantity of this proof solution, measuring about a quarter of an ounce, is put into a clear white glass moulded phial of two ounces capacity, which is then filled up with a solution of chloride of lime that has a specific gravity indicated by one-twelfth of a degree on Twaddell's hydrometric scale. This operation is repeated with eleven other phials of exactly equal diameter, the bleaching solution with which they are filled up being each time carefully made one-twelfth of a degree stronger, so that the last phial will be filled up with bleaching-solution of one degree in strength (= sp. gr. 1·005). They should all be well corked and placed side by side in a frame, leaving a little space between every other one.

The steeping solution used by calico-bleachers usually ranges from one-half to one degree Twaddell, and when weakened by the immersion of a parcel of goods, its strength is at once ascertained by filling up with it a phial containing proof solution similar to those just described, and placing it by the side of the standard phial nearest to it in colour; the strength of the solution in that phial being known, the strength of the bleaching-liquid tested is at once indicated. If now the quantity of steeping solution used in one operation is known, and if a concentrated solution of chloride of lime is kept in stock, made always of the same strength, a table may be constructed which shall show at a glance the amount of stock solution required to be added to the weakened steeping-liquor, to make it stand at the desired strength. These conditions always exist in bleaching-works. The steeping vessels described in Mr. Crum's paper required 1440 gallons of liquid to fill them up to a mark indicating the proper height for receiving goods, a quantity more conveniently expressed by 288 measures—a measure containing five gallons, the quantity most easily carried at a time. The stock solution of bleaching-powder was always made of a density indicated by six degrees on the scale of Twaddell's hydrometer. The following table was then constructed :—

To stand $\frac{8}{12}°$.		To stand $\frac{6}{12}°$.	
0 requires	32 measures.	0 requires	24 measures.
1 ,,	28 ,,	1 ,,	20 ,,
2 ,,	24 ,,	2 ,,	16 ,,
3 ,,	20 ,,	3 ,,	12 ,,
4 ,,	16 ,,	4 ,,	8 ,,
5 ,,	12 ,,	5 ,,	4 ,,
6 ,,	8 ,,		
7 ,,	4 ,,		
To stand $\frac{4}{12}°$.		**To stand $\frac{3}{12}°$.**	
0 requires	16 measures.	0 requires	12 measures.
1 ,,	12 ,,	1 ,,	8 ,,
2 ,,	8 ,,	2 ,,	4 ,,
3 ,,	4 ,,		

This table shows, for example, that if the steeping liquor is required to be of a strength indicated by $\frac{8}{12}$ of a degree Twaddell, the 288 measures must contain 32 measures of the stock-bleaching solution; if that steeping liquor is then weakened, and an experiment shows it to be of a strength equal to three degrees Twaddell, then to 268 measures of it, 20 measures of stock-bleaching solution will be required to be added to form 288 measures of steeping liquor of the original strength, $\frac{8}{12}°$. In fact, every twelfth of a degree requires four measures of stock solution in the 288 measures of steeping liquid.

CHLORINDOPTIC ACID, *Trichlorophenylic Acid, Chlorophenisic Acid* ($C_{12}H_3Cl_3O_2$), one of the chlorine substitution products of carbolic acid. [CARBOLIC ACID.]

CHLORINE (Cl), an elementary gaseous body discovered by Scheele in 1774 [SCHEELE, BIOG. DIV.], while examining an ore of manganese. He gave it the name of *dephlogisticated marine acid*. By the French chemists, in accordance with the views of Berthollet, it was called *oxygenised muriatic acid*, which was shortened by the English chemists to *oxymuriatic acid;* these latter terms meant that it was a compound of muriatic acid, a supposed elementary or at any rate an undecomposed body, and oxygen. Gay-Lussac and Thénard in 1809 published some experiments from which they inferred that oxymuriatic acid might be a simple substance, but they notwithstanding adhered for a considerable period to the opinion of its being a compound. About the same time Sir H. Davy commenced his examination of the same body, and from his numerous researches he concluded that it ought to be regarded as an undecomposed body; and on account of its colour, he gave this gas the name of chlorine, from χλωρός, *green*. Chlorine was first obtained by Scheele, by treating the binoxide of manganese with hydrochloric acid. During the mutual operation of these compound bodies, the oxygen of the binoxide combines with the hydrogen of the acid, and water is formed; the metal of the oxide remains combined with a portion of the chlorine, while the excess which the metal does not unite with is given out in the gaseous state, thus :—

$$\underbrace{MnO_2}_{\text{Binoxide of maganese.}} + \underbrace{2HCl}_{\text{Hydrochloric acid.}} = \underbrace{MnCl}_{\text{Chloride of manganese.}} + \underbrace{2HO}_{\text{Water.}} + \underbrace{Cl}_{\text{Chlorine.}}$$

At the present day the above process is largely adopted, on account of the cheapness of hydrochloric acid, which is obtained as a bye-product

in the manufacture of carbonate of soda from chloride of sodium (common salt). [SODIUM, *Compounds of.*]

Chlorine may also be obtained directly from chloride of sodium by heating four parts of the latter with three parts of powdered black oxide of manganese and seven parts of concentrated sulphuric acid, previously diluted with an equal weight of water. The decomposition that occurs is expressed in the following equation :—

MnO_2	+	NaCl	+	$2SO_3$	=	MnO, SO_3	+	NaO, SO_3	+	Cl
Binoxide of manganese.		Common salt.		Sulphuric acid.		Sulphate of manganese.		Sulphate of soda.		Chlorine.

Chlorine has a very powerful and disagreeable odour, is very suffocating, even when considerably diluted with air, and its taste is astringent. According to Davy, 100 cubic inches weigh between 76 and 77 grains at the average temperature and pressure, and with this determination the experiments of Gay-Lussac and Thénard nearly agree; its specific gravity is consequently about 2·47. Mr. Faraday found that when this gas is subjected to a pressure of about four atmospheres, and kept cool, it is condensed into a yellow limpid fluid, which is extremely volatile, and which, when the pressure is removed, rapidly reassumes the gaseous form; its specific gravity is about 1·33; its refractive power is less than that of water; and it is a non-conductor of electricity. Cooled to —220° it still remains liquid.

Chlorine gas is absorbed and dissolved by water, and when this fluid has been recently boiled, it will take up twice its bulk of the gas at common temperatures and pressure: the aqueous solution has the colour, smell, and taste of the gas itself. The equivalent of chlorine is 35·45, and when moist chlorine gas is exposed to a temperature of 32° Fahr., yellow crystals are formed, which are *hydrate of chlorine*, consisting, according to Mr. Faraday, of very nearly 1 equivalent of chlorine = 35·45 + 10 equivalents of water = 90. Neither light, heat, nor electricity, produces any change in the properties of chlorine gas, provided it be dry; but if it be moist, then light causes it to decompose the water, the hydrogen of which combines with it to form hydrochloric acid, while the oxygen is evolved in the gaseous form, and it was this experiment which chiefly induced Berthollet to adopt the opinion of its nature which has already been explained. In the decomposition of the compounds which contain it, it is evolved like oxygen at the positive pole, or anode; except when separated from oxygen, and then it goes to the negative or cathode.

One of the most curious and important properties of chlorine is the power which it possesses of destroying the colour of animal and vegetable matter in general, and hence its extensive application to the purpose of bleaching. [CHLORIMETRY.] When acids alter vegetable colours, they may in many cases be restored by the application of an alkali; but so complete is the destructive power of chlorine, that nothing whatever can reproduce the colour which it has removed. This power appears to depend upon the great affinity which exists between chlorine and hydrogen, the latter element being removed from the coloured compounds to form hydrochloric acid with the chlorine, while more chlorine takes the place of the hydrogen and colourless compounds result.

Chlorine gas is a supporter of combustion. If certain metals, and especially antimony, in the state of powder, be thrown into chlorine gas, they burn spontaneously; phosphorus also exhibits similar phenomena.

Chlorine is also a powerful disinfectant; for this purpose it was first employed by Guyton de Morveau; compounds of chlorine, and lime or soda, have been extensively used for this purpose.

Chlorine is in general easily detected by its odour and colour, whether in its gaseous state or in solution in water. It occasions a white precipitate in solution of nitrate of silver, which speedily darkens by exposure to light. This compound is called chloride of silver. It is insoluble in nitric acid, even when boiled, but is readily soluble in solution of ammonia. By this test, however, a portion only of the chlorine is thrown down; part of it uniting with the oxygen of the oxide of silver forms chloric acid, of which we shall presently make mention. It will be observed from the above statement that those compounds which contain chlorine are called chlorides; but this is the case only when such compounds do not possess acid properties.

Chlorine combines with almost every other elementary body, forming compounds of great importance; we shall first state the nature of those to which it gives rise by uniting with oxygen.

Oxygen and Chlorine combine in several proportions, but the combination is never immediate; and different views of the number and nature of the compounds are entertained by different chemists. The important ones are five in number,—

Hypochlorous acid	ClO
Chlorous acid	ClO_3
Peroxide of chlorine	ClO_4
Chloric acid	ClO_5
Perchloric acid	ClO_7

The other oxides of chlorine are probably merely compounds of those just enumerated with each other. Thus *euchlorine*, discovered by Sir Humphry Davy, a yellow explosive gas evolved when a chlorate is gently heated with hydrochloric acid, is a mixture of chlorine with *chlorochloric* acid ($2ClO_5$, ClO_3).

Chloric Acid (ClO_5).—It has been already mentioned that oxygen and chlorine do not combine by direct action; when however chlorine meets with nascent oxygen they unite. If chlorine gas be passed into water containing oxide of silver diffused through it, a portion of the chlorine combines with the silver and forms a chloride, which is precipitated; and the oxygen expelled from it uniting with another portion of chlorine, constitutes chloric acid, which remains in solution. Any excess of chlorine is to be expelled by heat. Or chloric acid may be made by adding dilute sulphuric acid to chlorate of baryta, in which case sulphate of baryta is precipitated, and chloric acid remains in solution. It is a colourless inodorous acid, which has a sour taste, and reddens vegetable blue colours. The solution may be concentrated by a gentle heat till it acquires an almost oily consistence; it has then a yellowish tint, a peculiar odour, and it sets fire to dry vegetable matters. It combines with bases to form salts termed *chlorates*, which were formerly known by the name of oxygenised muriates, or hyper or oxymuriates. Bodies which have a strong affinity for oxygen decompose chloric acid, by separating that element; thus sulphurous acid is converted into sulphuric acid by decomposing it, and taking its oxygen. Chloric acid is composed of—

1 equivalent of chlorine	= 35·45
5 equivalents of oxygen	= 40
	75·45

The chlorates, except that of potash, are not important salts: this however is used for many purposes; thus when it is heated it evolves very pure oxygen gas, and chloride of potassium remains; the oxygen is yielded both by the acid and the alkali. Chlorate of potash [POTASSIUM] is prepared on the large scale by passing chlorine gas into a solution of the alkali; part of the chlorine takes oxygen from part of the potash and forms with it chloric acid, which unites with the remainder of the potash to form the chlorate, while the remainder of the chlorine unites with the potassium to form chloride; both salts dissolve in water, but the chlorate crystallises first, and in rhombic plates. This salt detonates when triturated with sulphur; and when struck with phosphorus it explodes and inflames, and in both cases it yields oxygen.

Chlorate of potash is composed of—

1 equivalent of chloric acid	= 75·45
1 equivalent of potash	= 47·0
Equivalent	122·45

Chlorate of Baryta (BaO, ClO_5) is extensively used in the manufacture of fireworks.

Perchloric Acid (ClO_7) is procured by the partial decomposition of the chloric acid just described. It is obtained by mixing sixty grains of chlorate of potash with about four times its weight of sulphuric acid, and heating the mixture below 212° in a porcelain basin; a gas, which we shall presently describe, is given out, and there remains in the retort a mixture of bisulphate and perchlorate of potash; by washing with cold water the bisulphate is dissolved, and the perchlorate remains. When this salt is mixed in a retort with half its weight of sulphuric acid diluted with one third of water, and the mixture is heated to about 280°, the white vapour which arises is perchloric acid, which condenses in the receiver.

This acid is a limpid colourless liquid, has a sharp taste, and reddens litmus paper, without destroying its colour. When concentrated by evaporation its specific gravity is 1·65, and it then emits vapour when exposed to the air; it boils at 392°, and rapidly absorbs moisture from the atmosphere. When mixed with sulphuric acid and heated, the acid is distilled, and it concretes on cooling into a solid, which crystallises in prisms. It appears to be the most stable of all the compounds of chlorine and oxygen, not suffering decomposition either by the action of light, sulphurous, or hydrosulphuric acid; it dissolves iron and zinc, with the evolution of hydrogen gas.

The salts formed by this acid with bases are termed *perchlorates*: they are decomposed by heat, yielding much oxygen gas, and are converted into chlorides. The perchlorates are not an important class of salts.

Peroxide of Chlorine, or *Hypochloric Acid* (ClO_4) is a gaseous compound evolved during the formation of perchlorate of potash just described. This gas has a green colour; it has no smell of chlorine, but, on the contrary, an aromatic odour; it is readily dissolved in water, to which it imparts its own colour; the solution does not combine with alkalies; it destroys most vegetable blue colours without previously reddening them. When heated to 212° this gas explodes violently, emits a strong light, and the residual gases occupy more space than the compound did which they formed; 40 volumes of the gas becoming 60, of which 40 are oxygen and 20 chlorine.

The changes which occur in thus preparing perchlorate of potash and peroxide of chlorine are these: the sulphuric acid decomposing a portion of the chlorate of potash evolves chloric acid, which, at the moment of its liberation, is separated into oxygen and peroxide of chlorine; the oxygen combines with the chloric acid of the undecomposed chlorate, and converts it into perchloric acid, and consequently perchlorate of potash is formed, while the peroxide of chlorine, as

already noticed, is evolved in the gaseous state. When three equivalents of chlorate of potash are acted upon by sulphuric acid, there are produced two equivalents of peroxide of chlorine and one equivalent of perchloric acid.

By substituting oxalic acid for sulphuric acid, Messrs. Crace Calvert and E. Davis assert, that peroxide of chlorine may be prepared with far greater facility and much less danger. One equivalent of chlorate of potash (122·5 parts) and nine equivalents of crystallised oxalic acid (567 parts), well powdered and intimately mixed, furnish, when heated in a water-bath to a temperature of 158°, a steady stream of the gas, chloride of potassium and an acid oxalate of potash being left in the vessel. The peroxide of chlorine thus produced, however, always contains carbonic acid.

Chlorous Acid (ClO_3) is a dangerously explosive yellowish green gas, evolved when chlorate of potash, arsenious acid, and nitric acid are gently heated together. It possesses considerable bleaching powers, and forms definite salts, *chlorites*, with bases.

Hypochlorous Acid (ClO). This acid is thus obtained: add finely-powdered peroxide of mercury, mixed with twelve times its weight of distilled water, to chlorine gas in a bottle, and shake it well; the oxide of mercury should be slightly in excess, so that when the absorption of the chlorine, which goes on rapidly, is over, the residue should have a reddish rather than a white colour. The whole contents of the bottle are to be put in a filter, upon which there remains oxychloride of mercury, while the filtered liquor, when distilled in vacuo, yields weak hypochlorous acid, which may be concentrated by redistillation.

Hypochlorous acid thus procured is a transparent slightly yellow-coloured fluid; its smell is penetrating and very distinct from that of chlorine or the peroxide; its taste is extremely strong but not acid. When prepared by passing dry chlorine over dried precipitated peroxide of mercury, and condensing the gaseous product by aid of a freezing mixture, it presents the appearance of a deep red liquid, which boils at 68°. It attacks the epidermis with great activity, even more so than strong nitric acid, and imparts a brown stain to the skin. It is a very unstable compound, decomposing probably even at common temperatures. In hot weather it can be preserved for a few days only, without immersion in ice; when weaker and kept from the light, it may be preserved for a longer time. During decomposition it gives out small bubbles of chlorine gas, and some chloric acid is formed, and this decomposition is accelerated by agitation with angular bodies: it is decomposed by the action of light as well as by that of heat.

When to a concentrated solution of hypochlorous acid an equal bulk of solid dry nitrate of lime is added, a brisk effervescence is produced, which is owing to the separation of pure hypochlorous acid gas, which has the following properties: its colour is very little deeper than that of chlorine; its smell is penetrating like that of the solution; it is completely absorbed by mercury, which is transformed into a red oxychloride. It is best prepared by passing up a little of the gas at a time into a jar filled with and inverted in mercury; the nitrate of lime which is dissolved prevents the action of the liberated gas upon the metal: water dissolves nearly 100 times its volume of this gas; it is decomposed by heat with explosion. The fixed alkalies and the alkaline earths combine with hypochlorous acid.

The hypochlorite of lime, usually called chloride of lime, or bleaching powder, is a compound of great importance, both in the arts and as a disinfectant. [Calcium.] The exact composition of this compound is a subject still under discussion. Another compound, the nature of which is perhaps more problematical, is that formed by passing chlorine gas into a solution of carbonate of soda; the gas is plentifully absorbed without evolving any carbonic acid. This compound, like the hypochlorite of lime, is used as a disinfectant, under the name of Labarraque's soda liquor. With regard to the composition of the substances formed when chlorine is absorbed by the bases, chemists usually hold one of two opinions. First, that a double salt is formed, consisting of a chloride of the metal and a hypochlorite of the oxide of the metal, thus,—

$$\underbrace{2MO}_{\text{Oxide of a metal.}} + \underbrace{Cl_2}_{\text{Chlorine.}} = \underbrace{MCl + MO, ClO}_{\text{Double salt.}}$$

Second, that the chlorine unites directly and simply with the oxide of the metal, and that the so-called double salt merely consists of two equivalents of such a body, thus,—

$$\underbrace{MCl + MO, ClO}_{\text{Double salt.}} = \underbrace{2(MO, Cl)}_{\text{Chloride of metallic oxide.}}$$

The second view is the more probable one.

Nitrogen and chlorine combine to form the

Chloride of Nitrogen. This compound was discovered by Dulong in 1811. These gases do not combine by direct action, but when chlorine gas meets nitrogen gas in the nascent state they unite. It may be prepared by dissolving an ounce of chloride of ammonium in twelve to sixteen times its weight of water, and then inverting a bottle of chlorine gas in the solution. The chlorine is gradually absorbed, and there are formed small drops of an oil-like fluid which sink in the solution: these are the chloride of nitrogen, derived from the combination of the chlorine with the nitrogen of the ammonia.

The properties of this substance are that it is extremely explosive, sometimes detonating spontaneously, but always on the contact of fatty matter, phosphorus, and various other bodies. Its specific gravity is 1·653. It is not solidified by the most intense artificial cold. At 160° it may be distilled, but at 200° to 212° it explodes.

Chlorine and hydrogen combine to form the

Hydrochloric Acid (HCl), sometimes called *muriatic acid* and *spirit of salt.* When equal volumes of these gases are mixed and kept in the dark, they do not unite, but if exposed to daylight they combine slowly, and by the direct rays of the sun, the electric spark, or a taper, they unite with explosion, and there is formed a quantity of hydrochloric acid equal in volume to that of the two gases employed. As 50 cubic inches of hydrogen weigh 1·07 grain and 50 of chlorine 38·57 grains, their combined weight gives that of 100 cubic inches of the gas = 39·64 grains, or its specific gravity is 1·2474. This gas is colourless, has a very pungent odour, and an acid and acrid taste. It excites coughing, unless largely diluted with air; extinguishes burning bodies when they are immersed in it; and reddens vegetable blue colours strongly. By heat it is merely expanded, but by electricity it is decomposed. Under a pressure of forty atmospheres at 50°, it condenses to a colourless liquid, which the most intense cold does not solidify. The affinity of this gas for water is so great, that when it escapes into the air, it forms a white vapour by combining with atmospheric moisture; water absorbs 400 times its bulk of this gas, and the result is liquid hydrochloric acid, usually called hydrochloric acid.

As this acid is largely employed, it is prepared in a more economical manner than the direct formation of the gas, by decomposing common salt with sulphuric acid. For this purpose, 24 parts of common salt, termed chemically chloride of sodium, are mixed in a retort with 20 parts of sulphuric acid, and 12 of water, and into the receiver an equal quantity of water is put; by distillation to dryness, a colourless acid is obtained, which has a specific gravity of about 1·16.

For manufacturing purposes this process is usually conducted in iron vessels, and the product condensed in a series of stoneware (Woulfe's) bottles, or by conducting the gas through tall columns or towers filled with coke, down which a small current of water is made to trickle. The acid thus produced, though very strong, always contains a considerable quantity of iron and other impurities in solution, and is, therefore, always more or less coloured.

During the mutual action of the salt, acid, and water, a portion of the water is decomposed, which yields hydrogen to the chlorine, and these form hydrochloric acid, while its oxygen unites with the sodium, to form soda, which with the sulphuric acid constitutes sulphate of soda, which remains in the retort. This solution of hydrochloric acid has the smell and acid properties of the gas itself; it emits white fumes, and reddens litmus paper. It dissolves many metals, such as iron, zinc, and tin, and forms with them chlorides, the acid being decomposed and yielding hydrogen gas during their solution. These compounds will be treated of as chlorides, under the respective metals. Hydrochloric acid is largely employed in the arts connected with, or dependent upon, chemical operations, as in dyeing and calico printing, and in making chloride of ammonium or sal ammoniac [Ammonia]; it unites also with the vegetable alkalies, as morphia, quinine, &c., to form hydrochlorates; but with metallic oxides, it forms chlorides, and not hydrochlorates, on account of the decomposition which it suffers, as just explained. When mixed with the nitric acid also, it is decomposed, and a solution is obtained, which is used under the name of *aqua-regia*, or *nitro-muriatic acid*, or *nitro-hydrochloric acid*, for dissolving gold and platinum.

The strength of commercial hydrochloric acid is most readily ascertained by taking its specific gravity. The following table, slightly abridged from one drawn up by Dr. A. Ure, shows the per centage of hydrochloric acid gas in aqueous hydrochloric acid:—

Sp. gr.	Per cent.	Sp. gr.	Per cent.	Sp. gr.	Per cent.
1·200	40·77	1·158	31·81	1·112	22·83
1·198	40·37	1·155	31·39	1·110	22·42
1·196	39·96	1·153	30·99	1·108	22·02
1·194	39·55	1·151	30·58	1·106	21·61
1·193	39·14	1·149	30·17	1·104	21·20
1·191	38·74	1·147	29·76	1·102	20·79
1·189	33·33	1·145	29·36	1·100	20·29
1·187	37·92	1·143	28·95	1·098	19·98
1·186	37·52	1·141	28·54	1·096	19·57
1·185	37·11	1·139	28·14	1·094	19·16
1·182	36·70	1·137	27·73	1·092	18·76
1·180	36·29	1·135	27·32	1·090	18·35
1·178	35·88	1·133	26·91	1·088	17·94
1·176	35·47	1·131	26·51	1·086	17·53
1·174	35·07	1·128	26·09	1·084	17·13
1·172	34·66	1·126	25·69	1·082	16·72
1·170	34·24	1·124	25·32	1·080	16·31
1·168	33·84	1·122	24·87	1·078	15·91
1·166	33·43	1·120	24·44	1·076	15·50
1·164	33·03	1·118	24·05	1·074	15·09
1·162	33·62	1·116	23·65	1·072	14·68
1·160	32·21	1·114	23·24	1·070	14·28

Sp. gr.	Per cent.	Sp. gr.	Per cent.	Sp. gr.	Per cent.
1·068	13·86	1·044	8·99	1·020	4·08
1·066	13·46	1·042	8·58	1·018	3·67
1·064	13·05	1·040	8·17	1·016	3·26
1·062	12·66	1·038	7·76	1·014	2·85
1·060	12·25	1·036	7·36	1·012	2·45
1·058	11·84	1·034	6·95	1·010	2·04
1·056	11·43	1·032	6·54	1·008	1·63
1·054	11·03	1·030	6·13	1·006	1·22
1·052	10·61	1·028	5·72	1·004	0·82
1·050	10·20	1·026	5·31	1·002	0·41
1·048	9·78	1·024	4·90		
1·046	9·39	1·022	4·49		

Chlorine unites with several of the non-metallic bodies [BROMINE, IODINE, PHOSPHORUS, SELENIUM, and SULPHUR]. Having already given an account of boron and carbon, we shall briefly state the nature of the chlorides of these elementary bodies.

Chlorine and boron form

Terchloride of Boron (BCl_3). It was found by Davy that boron, when recently prepared, burns in chlorine gas; Berzelius remarked that if the boron be previously rendered compact, combustion does not occur until these elements are heated. The resulting compound is a colourless gas, which, when freed from excess of chlorine by means of mercury, has the following properties: it is colourless; its specific gravity is 4·079; it is readily soluble in water, by decomposing a portion of which hydrochloric and boracic acids are obtained: the same effect is produced, accompanied with a white vapour, when the gas escapes into the atmosphere. It combines with ammonia to form a crystalline compound, the nature of which has not been minutely examined.

Chlorine and *Carbon* form four different chlorides; namely, the dichloride, protochloride, sesquichloride, and bichloride. No combination can be effected between these elements by direct action; carbon, even heated to whiteness in the gas, does not form any compound with it. The discovery of several of these compounds is due to Mr. Faraday. ('Phil. Trans.' 1821.)

The *dichloride of carbon* (C_4Cl_2) is obtained from protochloride of carbon, by causing the latter to pass several times through a tube heated to bright redness. It occurs in small soft colourless fibres; it fuses when heated, and at 250° sublimes and condenses unchanged. It is insoluble in water, acid, and alkalies, but may be dissolved in hot oil of turpentine and in alcohol, recrystallising as the solutions cool; it burns with a red flame, yielding much smoke and hydrochloric acid vapour.

The *sesquichloride of carbon* (C_4Cl_6) which it will be most convenient, although not in strict order, to consider next, is formed when olefiant gas, a compound of hydrogen and carbon [CARBON], is mixed with chlorine; they combine to form an oil-like liquid which is composed of chlorine, carbon, and hydrogen; by exposure to the direct rays of the sun, hydrochloric acid and sesquichloride of carbon are formed by its decomposition.

This chloride is solid; its smell is rather aromatic; it is a non-conductor of electricity; its specific gravity is 2. It melts at 320°, and at a higher temperature may be distilled without suffering any change; water dissolves it but sparingly; it is soluble in alcohol, ether, and the fixed and volatile oils. Its vapour density is 8·157.

It burns when strongly heated, but is not acted upon either by acids or alkalies; when passed with hydrogen through a red-hot tube, hydrochloric acid is formed and carbon deposited.

The *protochloride of carbon* (C_4Cl_4) is obtained by passing the sesquichloride in vapour through a red-hot porcelain tube; chlorine gas escapes in such proportion as to reduce the sesquichloride to a protochloride, which is a limpid colourless liquid of specific gravity 1·552: it is not solidified at 0° Fahr. Its boiling point is 248°, and the specific gravity of its vapour 5·820. When repeatedly distilled it suffers no change.

The *bichloride of carbon* (C_2Cl_4) is best formed by passing chlorine through bisulphide of carbon, and the mixed vapours through a porcelain tube heated to redness. On condensing and purifying by washing and distillation, it is obtained as a limpid colourless liquid of specific gravity 1·599; boiling point 172°; vapour density 5·30. Cooled to —9° it solidifies to a mass of pearly crystals.

CHLORINE, *Medical Uses.*—When pure and concentrated, chlorine is very deleterious; it acts as an irritant poison. Its action is most violent and speedy when it is brought into contact with the respiratory organs; it then occasions such violent spasms of the glottis, or opening of the windpipe, that instant death may ensue. To enable chlorine to pass this orifice it must be very largely diluted with atmospheric air, or aqueous vapour. A strong solution of it introduced into the stomach causes irritation, inflammation, and death; and even a stream of the gas, or aqueous vapour of it, directed upon the skin, will cause a pricking or stinging sensation, followed by an eruption of pimples or even vesicles. Notwithstanding its formidable properties, it has been used in several cases with such success that no adequate substitute can be found for it. As a disinfecting agent, or means of decomposing and rendering innoxious putrid miasmata, and other sources of disease, it is unrivalled. For this purpose it may either be directly mingled with the air of the infected place, by preparing it on the spot, or by means of one of Morveau's disinfecting bottles; or it may be gradually liberated from some of its combinations, such as the chloride of soda or lime. This last method is best when human beings remain in the apartment; but the former is preferable, when they have been removed, for purifying the wards of hospitals, cells of gaols, or holds of ships. When not in a very concentrated form, the respiratory organs become habituated to breathing it, and the workmen in manufactories where it is used enjoy a marked immunity from epidemic fevers, and attain a considerable age.

From having been observed to allay chronic cough existing among the workmen of certain manufactures, it has been proposed to be inhaled in a diluted state in several chronic affections of the lungs, such as asthma, chronic bronchitis, and even phthisis pulmonaris, or consumption. In the two former it is of some utility, in the latter it is a mere palliative, but is attended with the advantage of destroying the fœtor of the breath, which is distressing both to the patient and attendants. The chlorine employed in this way must be extremely pure, the preparation frequently renewed, of uniform strength of 1½ volume of chlorine in solution, and carefully preserved from the sunlight, which decomposes it. It may be breathed in a small quantity out of a proper apparatus four or five times a day.

A weak solution of chlorine has been employed, introduced into the stomach, with considerable success in indigestion, with loss of appetite, loaded tongue, and foul taste in the mouth.

Its employment in the form of a bath is not common, but occasionally useful, from its irritant effect on the skin. It is doubtful whether it possesses the specific effect upon the liver which some ascribe to it.

In case of poisoning by the gas, inhaling ammonia or sulphuretted hydrogen in small quantity is useful. Should an overdose of the solution be swallowed, chalk, magnesia, or other alkali, or white of egg in water, or a draught of milk, would be proper as an antidote. On the opposite hand, chlorine is said to be a valuable antidote in case of poisoning by hydrocyanic (prussic) acid, sulphuretted hydrogen, or hydrosulphate of ammonia.

CHLORIODIC ACID, *Choride of iodine*, a compound of chlorine and iodine, which on account of its acid properties was termed an acid by Davy, but by Gay-Lussac simply *chloride of iodine*, he being of opinion that the acidity of its solution arises from the presence of hydrochloric and iodic acids, generated by the decomposition of water.

Iodine, when dry, absorbs chlorine at common temperatures with the evolution of heat: when the iodine is perfectly saturated with chlorine, the compound is orange-yellow, but reddish-orange if the iodine be in excess. By heat it is converted into a yellow-coloured liquid, yielding a vapour of the same colour when the temperature is increased. It is deliquescent, readily soluble in water, and forms a colourless solution which is very sour to the taste, first reddens and then destroys vegetable blue colours. It probably consists of 1 equivalent of chlorine and 1 equivalent of iodine.

CHLORIODOFORM (C_2HCl_2I). This body, which may be regarded as chloroform, in which one equivalent of chlorine has been replaced by iodine, is obtained by heating iodoform with bichloride of mercury. It is a yellow liquid of an aromatic odour, and a specific gravity of 1·96.

CHLORISATHYDIC ACID, a chlorinated substitution product derived from indigo.

CHLOROCARBOHYPOSULPHURIC ACID. [TRICHLORMETHYL-SULPHUROUS ACID.]

CHLOROCARBONIC ACID GAS, *Oxychloride of Carbon* (COCl) This acid, called by Dr. Davy, who discovered it, *phosgene gas* (from φῶς, light, and γεννᾶν, to produce), was formed by exposing a mixture of equal volumes of dry chlorine and carbonic oxide gases to the solar rays; combination takes place rapidly, but without explosion, and they contract to half their bulk; day-light produces the effect slowly, but in the dark it does not take place at all.

Chlorocarbonic acid gas is colourless, has a strong smell, and reddens litmus paper even when dry; it decomposes water, and there are formed hydrochloric and carbonic acids. Several metals when heated in it decompose it; they are converted into chlorides, and carbonic oxide is evolved. The specific gravity of this gas is 3·68. When mixed with ammoniacal gas it condenses four times its volume, and forms chloride of ammonium and carbamide,

$$2(NH_3) + COCl = NH_4Cl + NCOH_2.$$

CHLOROCHLORIC ACID. [CHLORINE.]

CHLOROCHROMIC ACID. [CHROMIUM.]

CHLOROCINNOSE ($C_{14}H_4Cl_4O_2$), a compound produced by the action of chlorine upon oil of cinnamon. When pure, it exists in the state of brilliant, colourless, acicular crystals, which fuse and volatilise by heat without change. Even when heated in concentrated sulphuric acid it is not decomposed, nor is it altered by heating in ammoniacal gas. It appears that its formation depends upon the displacement of 4 equivalents of hydrogen from oil of cinnamon by 4 equivalents of chlorine.

CHLOROCYANIC ACID. [CYANOGEN.]

CHLORODRACONESIC ACID ($C_{16}H_7ClO_6$), *chloranisic acid*, a chlorinated substitution product derived from anisic acid. [ANISIC ACID.]

CHLOROFORM (C_2HCl_3), a peculiar compound fluid, obtained about the same time by Soubeiran and Liebig. To procure it, distil a mixture of alcohol and a solution of chloride of lime; separate the product from the liquid distilled with it, shake it with five or six times its volume of concentrated sulphuric acid; pour it off, mix with a little sulphuric acid, distil, and rectify from chloride of calcium.

Chloroform is a limpid fluid; its specific gravity is 1·480; it boils at about 141° Fahr.; does not readily burn, but when a glass rod moistened with it is put into the flame of a spirit lamp, it burns with a yellow sooty flame fringed with green. It is soluble in alcohol and ether; water precipitates it from them; it dissolves iodine, phosphorus, and sulphur; is not decomposed by potassium; but when this metal is heated in its vapour, combustion and explosion ensue, chloride of potassium is formed, and charcoal is deposited. Heated with alcoholic solution of potash, it yields formiate of potash.

Pure chloroform, when dropped into water, falls to the bottom without becoming milky. If chloroform contain alcohol it is coloured green when mixed with bichromate of potash and sulphuric acid. Chloroform is the best solvent for caoutchouc and gutta-percha; on the evaporation of these solutions, the gums are left with all their properties unaltered. When gutta-percha is thus treated it becomes white, like ivory.

A large amount of the chloroform now manufactured is made from *methylated spirit*, which if properly treated yields chloroform equal in purity to that furnished by duty-paid alcohol. Chloroform is almost exclusively employed in medicine as an anæsthetic. [Methyl; Anæsthetics.]

CHLOROGENIN. [Madder, Colouring Matters of.]

CHLOROGINIC ACID. [Caffeine.]

CHLOROMELAL ($C_{120}H_{91}Cl_{29}O_2$?), a resinous body, produced by the action of chlorine upon hydrate of myricyl.

CHLOROMETHYLASE, *bichlorinated ethylene*? ($C_4H_2Cl_2$), an oily product obtained by the action of chlorine upon acetate of methyl.

CHLOROMETHYLSULPHUROUS ACID, *chloromethyldithionic acid* ($C_2H_3ClS_2O_6$), a chlorinated derivative of methylsulphurous acid.

CHLORONICEIC ACID. This acid has recently been proved to be identical with chlorobenzoic acid.

CHLORONICINE. This product, derived from oxyphenic acid, and to which the formula $C_{20}H_{12}Cl_2N_2$ had been assigned, is, in all probability, either identical or isomeric with chloraniline ($C_{12}H_6ClN$).

CHLORONITRIC GAS. [Nitrohydrochloric Acid.]

CHLORONITROUS GAS. [Nitrohydrochloric Acid.]

CHLOROPHANE. [Calcium, *fluoride of*.]

CHLOROPHENISIC ACID. [Chlorindoptic Acid.]

CHLOROPHYLL, *Chromule*. The colouring matter of leaves has been thus named by Pelletier and Caventóu. It is obtained by bruising, pressing, and then washing them with water, and afterwards treating them with alcohol, which dissolves the green colour and wax; when water is added to this solution, and the alcohol distilled, the green substance, which contains wax, floats on the surface of the water; when this is heated with ether, the wax is dissolved, and chlorophyll remains nearly pure. When exposed to light, or the action of chlorine, it is bleached. Acids produce a similar effect, and by the alkalies it is converted into soap. The red tint which leaves assume in autumn appears to be owing to the formation and action of an acid; the green colour is restored by an alkali. Its composition is not known.

CHLOROPICRIN, *chloride of perchlorinated nitromethyl* [$C_2Cl_3(NO_4)$], a colourless, transparent oil, obtained by the action of chloride of lime upon picric acid.

CHLORORUBIN. [Madder, Colouring Matters of.]

CHLOROSAMIDE, *Hydride of chloronitrosalicyl* ($C_{42}H_{15}Cl_3N_4O_6$). A yellow crystalline product obtained by passing a current of dry ammoniacal gas into hydride of chlorosalicyl.

CHLOROSUCCIC ACID ($C_6HCl_3O_4$?), a chlorinated derivative of succinic acid. [Succinic Acid.]

CHLOROUS ACID. [Chlorine.]

CHLOROXETHIDE. [Oxalic Acid.]

CHLOROXYNAPHTHALIC ACID. [Madder, Colouring Matters of.]

CHOCOLATE AND COCOA. Much confusion arises from the application of the name *cocoa* to two entirely different plants, having no connection whatever with each other. This is the more absurd because the name is not strictly applicable to either; the one being properly *Cocos*, and the other *Cacao*. Again, there is no general appreciation of the difference between *cocoa* and *chocolate*. Referring to the Natural History Division for an account of the botanical characteristics of the respective plants, we shall here briefly notice the commercial distinctions in their relation to manufactured products.

Cocos.—One of the most valuable of tropical trees is the *Cocos nucifera*, the nut-bearing cocos, or cocoa-nut tree. Scarcely any other tree is applied to so many uses by the natives of the countries in which it flourishes. The roots are chewed in place of the areca-nut; gutters, drains, and the posts of huts are formed from the trunk; the young buds are a delicate vegetable. Shade is furnished by the leaves when growing, and after separation from the tree their large size and hard texture render them invaluable as thatch for cottages; they are, moreover, manufactured into baskets, buckets, lanterns, articles of head-dress, and even books, upon which writing is traced with an iron stylus. Their ashes yield potash in abundance; their midrib forms oars; and brushes are formed by bruising the end of a leaf with a portion of the midrib adhering to it. From the juice of the stem a kind of palm wine, and subsequently an ardent spirit, are prepared; the farinaceous matter contained in the stem is a good substitute for sago; and a coarse dark-coloured sugar, called jagghery, is obtained by inspissating the sap. This jagghery, mixed with lime, forms a powerful cement, which resists moisture, endures great solar heat, and will take a fine polish. The ripe fruit is a wholesome food, and the milk it contains yields a grateful cooling beverage; indeed, these together constitute the principal sustenance of the poorer natives in many tropical countries. The fibrous bark is used to polish furniture, as brushes, and to form a valuable elastic bark is cordage called *coir*; the fibrous matter of the husk is also employed to stuff mattresses; and a manufacture of it into cordage, mats, sacking, &c., has sprung up in Great Britain. The shell is made into drinking-vessels and vessels of measure; and, finally, the albumen, or white solid matter contained within the shell, yields by pressure or decoction an excellent oil. This oil is not only employed for burning and for making candles, but in the manufacture of torches, and in the composition of pharmaceutical preparations; and mixed with dammer (the resin of *Shorea robusta*) it forms the substance used in India for caulking the seams of boats and ships. Cocoa-nuts are brought to Europe as wedges to set fast the casks and other round packages in the cargo of vessels; their freight therefore costs nothing. They constitute the part of the plant best known in this country, chiefly for its palatable fruit. In reference to manufactures, the nut is more largely valuable, on account of the oil which it contains. In Ceylon, the natives expose the ripe nuts on mats to the heat of the sun, and bring them to a certain state of dryness; they are sent in this state to England, under the name of *copperah*. When the natives express the oil themselves they call the refuse oil-cake by the name of *poonac*; this also finds a market in England. For home purposes the Cingalese do not obtain the oil by pressure; they simply boil the fresh pulp, and skim off the oil as it rises. When they prepare the oil for exportation to England, they expose the copperah to the action of a press worked by bullocks, and obtain about two gallons and a half of oil from a hundred average-sized nuts. Steam-power has lately been used to supersede the less effective labour of bullocks. The oil is largely used in the manufacture of candles and soap. A kind of cocoa-nut butter is obtained from another species of the tree, the *Cocos fusiformis*, or great macaw tree, in Trinidad, Jamaica, and South America. The nuts are slightly washed, cleansed, and ground to paste in a mill, and then on a stove; the paste is next heated, and mixed with 30 per cent. of its weight of boiling water. The mixture is put into a bag, and pressed between two hot iron plates, by which it is made to yield 75 per cent. of its weight of oil. This oil, when purified by filtration, somewhat resembles butter in appearance, with a golden-yellow colour, an odour of violets, and a sweetish taste. It enters largely into use for toilet soaps. So far as concerns the true cocoa-nut oil, it is imported more and more largely every few years: between the years 1845 and 1847, the quantity ranged from 30,000 to 50,000 cwts. yearly; between 1848 and 1852, from 60,000 to 100,000 cwts.; and between 1853 and 1858, from 130,000 to 250,000 cwts. The operations carried on by the Price's Patent Candle Company, at Vauxhall and elsewhere, have effected more than anything else in bringing this kind of oil into use in this country. [Candle Manufacture.]

Cacao.—We now come to the plant which really yields the so-called *cocoa* of the breakfast-table, and its off-shoot *chocolate*. The nut, bean, berry, seed, or kernel (for it has been called by all these names) of the *Theobroma cacao* is the part of the plant employed for this purpose. To prevent confounding this with the nut of the *Cocos nucifera* (just described), we will call it a *bean*. The Mexicans call the tree *chocolatl*, and hence the European name for one of the preparations derived from it. If the beans and husks be roasted, and then ground, the result is a pasty mass, which constitutes cocoa; or sometimes the nuts are pressed to obtain a certain portion of oil, and then the remaining cake is ground up into paste. As if to increase the confusion above adverted to, the name of cocoa-oil, or cocoa-nut oil, is often given to this oil, as well as to that obtained from the fruity cocoa-nut; but sometimes the better, because more distinctive, name of *butter of cacao* is given to it. To obtain this butter or oil, the beans are confined in strong canvas bags, and pressed by hydraulic machines at a certain temperature; the oil which flows out is agitated or churned with dilute sulphuric acid, then allowed to settle, then skimmed and decanted, and lastly filtered. It is used as oil for lamps, and as a substitute for cod-liver oil in medicines. *Cacao stearine* is produced from the cake which remains when the oil has been pressed out by steaming, dissolving, settling, and cooling; it is combined with other fatty matters in making soap and candles.

The cocoa prepared as a beverage is, as we have said, made either from the roasted and ground beans or from the oil-cake. A cheap and common kind is made from the oil-cake of damaged beans, mixed with flour, meal, suet, fat, &c.; it can be sold as low as 4*d*. or 6*d*. per lb. *Flake* cocoa consists of roasted and ground beans compressed into a hard substance, and then sliced or flaked by a machine. *Soluble* cocoa consists of the bean ground fine, and mixed with sugar and meal to render it more soluble in water. In roasting the beans for converting the *cacao*

into *cocoa*, care is taken to stop the roasting as soon as the aroma is developed; they are then turned out, cooled, and husked. On a large scale, the roasting and husking are conducted by the aid of well-constructed machinery; on a small scale, a common frying-pan would suffice for the roasting, if care were taken in the process. Dr. Lindley, in a lecture on the results of the Great Exhibition of 1851, said: "We have the evidence of one of the most skilful brokers in London, who has had fifty years experience to enable him to speak to the fact, that we never get good cocoa in this country. The consequence is, that all the good chocolate is made in Spain, France, and the countries where the fine description of cocoa goes. We get cocoa which is unripe, flinty, and bitter, having undergone changes that cause it to bear a very low price in the market." He showed that differential duties had had something to do with this, and then proceeded: "Still, it appears to me, that we might supply from our own colonies this very cocoa. There was exhibited, from Trinidad, a very beautiful sample, quite equal to anything produced in the best markets of the Magdalena, and of other places on the Spanish Main. It had no bitterness, no flintiness, no damaged grain in it; but all were plump and ripe, as if they had been picked. The cocoa from the Spanish Main [South America?] goes into other countries for the preparation of that delicious chocolate which we buy of them."

Chocolate.—Chocolate is nothing more than breakfast-cocoa carried to a little further stage of preparation. The Mexicans, to whom its name is due, are said to prepare it better than it is usually prepared in England. They roast the cocoa-beans in an iron pot pierced with holes; then pound them in a mortar, grind the powder to a paste between two stones, sweeten the paste with sugar, and add to it one or two of the following ingredients: long pepper, arnotto, vanilla, cinnamon, cloves, aniseed, musk, or ambergris. The Spaniards flavour their chocolate with vanilla, cloves, and cinnamon, and often scent it with musk and ambergris, in the Mexican fashion; this is then called *Spanish* chocolate. The *French* chocolate is made from the best Caraccas beans, a good deal of refined sugar, and a little vanilla. In England we have a large variety of prepared chocolates, under the names of *medicated, hygienic, homœopathic, aromatic, chalybeate, purgative, jalap, scammony, vermifuge,* &c.—all deriving their distinctive qualities from the addition of certain drugs or pharmaceutical preparations to the chocolate.

Like many other articles of prepared food, cocoa and chocolate are often disgracefully adulterated with nearly worthless substances, to enable fraudulent dealers to undersell their neighbours. Chemists have discovered, by careful analysis, starch, treacle, flour, potato-meal, sago-meal, and colouring earthy matter, mixed up with various samples of cocoa and chocolate sold in the retail shops of London.

Cocoa is now so highly prized, both as a pleasant and as a nutritious beverage, that physicians recommend it as a portion of the dietaries for soldiers, sailors, emigrants, invalids, &c.; and English private families largely use it.

CHOIR is, according to the common acceptation of the word, that part of a cathedral, between the chancel and screen, in which divine service is performed; it is separated from the nave by the screen, over which the organ is, in England and Ireland, very commonly placed. But the word is now frequently employed by writers on Gothic architecture in the same sense as chancel: that is, to designate that part of a church, whether cathedral or parochial, eastward of the nave, in which the service of the communion is performed.

The choir is also the term by which the lay-vicars, or lay-clerks, and choristers, that is, the singers, of a cathedral, are collectively designated. Their number in each cathedral varies, in most cases in proportion to the degree of integrity possessed by the respective dean and chapter at the Reformation, and subsequently. But, generally, the dignitaries contrived to retain as scanty a portion as possible of the musical members of the church. The choral service in the English churches had been much neglected, but it is now generally performed in a far more reputable and decorous manner than was the case forty or fifty years back; in most of our cathedral, and in many parish churches, the choral service is now very efficiently performed. The Exeter Hall performances, and the Handel Festivals at the Crystal Palace (1857 and 1859), have had much influence in spreading a taste for sacred music.

CHOKE DAMP. [Carbonic Acid.]

CHOLACROL ($C_{16}H_{10}(NO_4)_4O_{10}$?), one of the products of the oxidation of choloidic acid with hot nitric acid. It is a heavy oily body, found at the bottom of the receiver containing the products of condensation. It is purified by washing with water, in which it is insoluble. Alcohol and ether dissolve it with facility. It has a very acrid odour. For the other product of condensation, see Nitrocholic Acid.

CHOLALIC ACID ($C_{48}H_{40}O_{10}$), produced by the action of alkalies on cholic acid or choleic acid. The acids are boiled for a long time with solution of potash, or, better, baryta water; the concentrated liquid then deposits a crystalline mass, which may be decomposed by hydrochloric acid, and the residue, after evaporation nearly to dryness, dissolved in alcohol and recrystallised. From solution in alcohol, it separates in tetrahedra or octohedra, and from water in rhombic tables.

Cholalic acid decomposes soluble carbonates with effervescence, and combines with most bases to form salts, some of which are crystalline.

CHOLEIC ACID ($C_{52}H_{45}NO_{14}S_2$), (*Sulphocholeic acid; Taurocholic acid; Taurocholalic acid*). Of the two acids that, combined with soda, occur in ox-bile, choleic acid is alone the one that contains sulphur. It is also less abundant than cholic acid, the other constituent, but in the bile of serpents and fishes is by far the principal ingredient. It is best prepared by precipitating aqueous solution of ox-bile, first with neutral acetate, and then with subacetate of lead, till clear, white, plaster-like precipitates are obtained. The filtered liquid will now give with subacetate of lead and free ammonia a precipitate consisting almost exclusively of choleate of lead. This compound is washed with water, dissolved in alcohol, and reprecipitated by water; twice or thrice treated in a similar way; and finally decomposed by passing sulphuretted hydrogen through water, in which it is suspended. The filtered solution, by evaporation to dryness, yields choleic acid as a grayish-white mass.

Boiled with alkalies, it is decomposed into cholalic acid, mentioned above, and *taurin* [Taurin], thus:—

$$\underbrace{C_{52}H_{45}NO_{14}S_2}_{\text{Choleic acid.}} + 2HO = \underbrace{C_4H_7NO_6S_2}_{\text{Taurin.}} + \underbrace{C_{48}H_{40}O_{10}}_{\text{Cholalic acid.}}$$

Choleic acid forms, with the alkalies, salts, soluble in water and alcohol. With baryta, it forms a crystalline combination. It gives a purple colouration with sugar and sulphuric acid, similar to that produced by cholic acid.

CHOLEPYRRHIN. The brown colouring matter of human bile. It is readily altered by re-agents. The alteration in colour produced by nitric acid has been proposed as a method of detecting bile in urine, which, if bile be present, becomes first green, then blue, and finally violet, when nitric acid is added to it.

CHOLERA, from χολὴ and ῥέω, signifying *bile-flux*, a disease which has derived its name from its supposed cause, a preternatural quantity and a morbid quality of the biliary secretion.

The first symptom of this malady commonly consists of griping pains of the bowels; these are soon followed by vomiting and purging: there is always a redundancy and an altered condition of the bile, and, in some cases, after the vomiting and purging have continued for some time, there supervene spasms in different parts of the body, but particularly in the upper and lower extremities, and more especially in the legs. The tongue is usually dry, the thirst urgent, and the urine scanty. The pulse, at first free and frequent, as the disease advances becomes smaller and weaker, and the strength is very rapidly reduced. This form of the disease is commonly termed *bilious cholera*.

The chief exciting causes of this malady appear to be particularly connected with temperature. It rarely if ever attacks in the spring, at least in this country, while it is seldom altogether absent in the latter part of summer, and particularly when summer is passing into autumn. Hence its exciting cause would appear to be not so much a high temperature as an alternation of temperature from heat to cold, such an alternation constantly taking place at this season of the year, and occurring every day, in the great difference that takes place between the temperature of the day and that of the night. Accordingly this disease is observed to be by far the most frequent and the most severe at the seasons when those alternations are the most remarkable; when, for example, cold easterly or northerly winds suddenly set in after hot weather, and, above all, when this cold is combined with a moist atmosphere, as "during very warm summers and autumns occurring after a very rainy winter and spring, or after a succession of wet seasons, and when the days have been warm, bright, and sunny, and the nights cold with heavy dews." When such a concurrence of circumstances takes place in a high degree, the disease becomes so prevalent as to be as truly epidemic as any of the forms of fever common to the climate.

It is generally conceived that the use of certain kinds of fruit which abound at this season, as cucumbers and melons, and certain vegetables, as peas and the undressed vegetables used in salads, are powerful concurrent causes. In persons very much predisposed to this malady, such articles of diet may co-operate with the season to produce it; but when the state of the season is such as to render the disease epidemic, it attacks numbers of persons who never use food of this kind. Animal food of a bad quality or too long kept, as animal food of all descriptions is very apt to be at this season of the year, is a much more powerful concurrent cause. So also is excess of food, though of the best quality, and intemperance in the use of malt, vinous, and spirituous liquors; together with whatever causes tend to diminish the vital energies, and so to lessen the power of resistance inherent in the body to the influence of noxious agents.

There is reason to believe that certain poisonous particles of matter, derived from decayed vegetable and animal substances, and diffused in the atmosphere, are among the most powerful exciting causes of cholera, as it is certain that they are of fever. Hence it has been observed that to certain districts in some southerly climates, particularly between the tropics, bilious cholera may be said, from the frequency of its occurrence, to be strictly endemic, although in a less marked degree than certain forms of fever or dysentery. "According to my own observation," says Dr. Copland, "and that of several friends whose range of experience has been great, bilious cholera is very prevalent in situations which are subject to emanations from decayed vegetable matter, or putrid matter of any description, particularly from swamps, moist ground, the banks of rivers, lakes, or canals, &c., and from foul

drains or cesspools, during warm seasons, or wide and rapid changes of temperature; or when the thermometer rises high during the day, and sinks low towards the night and morning."

The presence of these miasmata as the cause of cholera accounts for the much greater prevalence and severity of this disease, in this country, in ancient than in modern times. The account given by Sydenham, who wrote about the middle of the 17th century, of the regular annual return of cholera and of its great fatality, may well make us rejoice at the altered condition as to cleanliness of our streets, drains, and houses, and at the different kind and better quality of our food.

"This disease," says Sydenham, writing of cholera as it appeared in London in the year 1699, "comes as certainly at the latter end of summer and at the approach of autumn as swallows at the beginning of spring, and as cuckoos at the heat of the following season. That disease which is occasioned by a surfeit comes at any time; the symptoms are indeed alike and the cause the same, yet it is of another kind. The cholera is easily known, for there are violent vomitings and an evacuation of ill humours with great difficulty and trouble by stool: there is a violent pain and inflammation of the belly; a heart-burning, thirst, a quick pulse with great anxiety, and often a small and unequal pulse with great nausea and sometimes a colliquative sweat, contractions of the arms and legs, fainting, a coldness of the extreme parts, and such-like symptoms, which frighten the bye-standers and kill the patient in twenty-four hours."

The persons most liable to bilious cholera are either those whose bowels are preternaturally irritable, and who are consequently subject to diarrhœa, or those whose bowels are torpid, and who are consequently subject to habitual constipation. In the latter case it is probable that the biliary secretion is sometimes long retained in the gall-bladder, where it becomes changed in nature, and acquires irritating properties.

Bilious cholera is rarely fatal in this country, excepting at seasons when the concurrence of circumstances is peculiarly favourable to the production of a severe form of the disease, and when at such seasons it attacks persons very much predisposed to it, and whose constitutions have been previously enfeebled by other causes. Its ordinary duration is from twenty-four hours to three or four days, when it often spontaneously disappears; but in general medical aid is indispensable; and when the attack is severe, if such aid be not promptly afforded, the danger of the disease and the difficulty of the cure are very seriously increased.

The milder forms of bilious cholera may pass away without the occurrence of any degree of spasm; but when the attack is severe, spasm is as constantly present as vomiting or purging. And cases now and then occur in which the spasm comes on so early and is so prominent as to give its own name, *spasmodic cholera*, to the disease. Spasmodic, by no means as frequent as bilious cholera, is on the other hand a much more formidable malady. It is indeed the same in nature, and arises from precisely the same causes, but its intensity and danger are widely different. Its attack is often immediately preceded by a sense of chilliness or a distinct rigour; the griping pains are more severe than in bilious cholera; the vomiting and purging are more urgent; the matter rejected consists of a watery or slimy fluid, and very soon there come on painful and violent spasms, which attack the muscles of the abdomen, thighs, legs, thorax, and lastly the arms and hands. These symptoms are attended with a small, quick, and contracted pulse, great thirst, and the immediate rejection of whatever is taken into the stomach. "As the disease proceeds," says Dr. Copland, who witnessed its progress in an intertropical climate, and who experienced it in his own person, "the pulse becomes weaker and smaller; the spasms more general; the purging constant and painful, generally with tenesmus; the vomitings are renewed upon the ingestion of substances into the stomach; and the powers of life rapidly fail. During this time the fluids evacuated from the stomach and bowels present no appearance of bile, although occasionally bile is seen in the evacuations to a small extent. In the course of a few hours the features shrink, the hands and feet become cold and clammy; the exacerbation of the spasms forces out a cold clammy sweat on the face and breast; the pulse is extremely small and weak, or nearly disappears. In a case which came before me in Africa, in 1816, the pulse could scarcely be felt four hours from the attack; and the contents of the stomach are now, in the more dangerous cases, thrown off without any effort of retching. Commonly during all this time the fæcal matters and the biliary secretions are retained, apparently owing to the extension of the spasms from the duodenum to the common biliary duct, and to spastic constrictions of parts of the colon; the epigastrum and hypochondria being sore, tense, and tumid. When the disease is treated with decision, the vomitings cease; free evacuations with a discharge of bile take place, and the patient soon recovers. But if neglected, or improperly managed, the powers of life fail rapidly; the eyes sink, and are surrounded with a livid circle; the countenance assumes a remarkably anxious cast, or is pale, wan, and shrunk; and the spasms extend to the very fingers. The breathing now becomes extremely laborious; the patient is restless, and at last is carried off, sometimes in the space of ten or twelve hours."

The pathological state constituting the disease seems to consist of irritation of the mucous surface of the digestive tube, commencing in the duodenum and extending in each direction to the stomach, small intestines, and along the common duct to the gall-bladder and liver, with increased action of the muscular coats of these viscera and determination of the circulating fluid to them. This irritation or morbid excitement, owing to the connexion of the organic nerves supplying those parts, is propagated to the spinal nerves, by which the muscles of the abdomen and extremities are affected by painful and violent contractions; and it is chiefly owing to the exhaustion of the vital manifestations of the organic system of nerves, and to the frequent and profuse discharges, that a fatal issue takes place: the circulating organs, which are actuated by this system, being in consequence incapable of performing their functions.

In regard to the treatment, Sydenham recommends in the early part of the attack the promotion of the discharge of the offending matter by means of diluents, such as weak broths and soups; and since his time this practice has been very generally followed. When the discharge has continued some time opium is indispensable, which is best given in the form of pill, in doses of from one to three grains, repeated at short intervals. The muriate of morphia, in doses of from half a grain to two grains, is also an excellent remedy. In some cases the opium should be combined with calomel; and in the intense forms of this disease, common in warm climates, twenty grains of calomel combined with opium, repeated once or twice after an interval of from three to six hours, is found by experience to be the most effectual remedy. Under such circumstances these large and repeated doses of calomel do not salivate, partly because the whole of the calomel is never retained, and partly because the system is not in a condition favourable for the absorption of what does remain in the stomach.

The malady, new to this climate, which has spread to so many different nations of the globe, and which has swept away so many of its inhabitants, commonly known under the name of *pestilential*, or *Asiatic cholera*, is a different disease from that here treated of, and is noticed under the article PESTILENCE.

(For a minute account of the symptoms, and for the details of the treatment of bilious and spasmodic cholera, see Sydenham's works; Dr. James Johnson *On Diseases of Intertropical Climates;* Dr. Chisholm *On Diseases of Tropical Climates;* and Dr. Copland's *Dict. of Pract. Med.*)

CHOLESTERIC ACID ($C_{10}H_{10}O_{10}$?), one of the final products of the oxidation of either of the bile constituents with nitric acid. It is most conveniently obtained by saturating the mother-liquor, from the preparation of choloidanic acid, with ammonia, precipitating with nitrate of silver, and re-dissolving the precipitate in boiling water. On cooling, crystalline scales of *chloresterate of silver* separate, from which the acid may be isolated by suspending them in water, decomposing with sulphuretted hydrogen, filtering, and evaporating the solution to dryness.

Cholesteric acid is a yellowish, solid substance resembling cherry-tree gum. Its taste is sour and bitter. It is very soluble in water, alcohol, and acids. It forms soluble non-crystalline salts with the alkalies.

CHOLESTERILIN ($C_{52}H_{42}$) is obtained in three isomeric modifications by the action of concentrated sulphuric acid on cholesterin: *a* has an earthy appearance; *b* occurs in spangles; *c* is resinous and non-crystalline. They all yield cholesteric acid by oxidation with nitric acid.

CHOLESTERIN ($C_{52}H_{44}O_2 + 2$ Aq.). This substance is a constant constituent of bile, though in very small quantity. It is also found in the blood, the brain, and in the yolk of egg. It frequently accumulates in the gall-bladder, forming what are called *gall-stones;* and it is from this variety of calculus that it is most easily prepared. Powdered and boiled with alcohol, the cholesterin dissolves, and crystallises out on cooling. It is obtained quite pure by one or two re-crystallisations.

Cholesterin is insoluble in water, slightly soluble in cold alcohol, very much so in boiling alcohol, ether, or wood-spirit. It fuses at about 280° Fahr. into a colourless liquid, that again becomes crystalline on cooling. Heated to near the boiling point of mercury, it volatilises without decomposition, forming a snowy-white sublimate. In the open air it burns with a smoky flame. The alkalies do not act upon it. Strong acids convert it into *cholesterilin* or *cholesteron*.

CHOLESTERON ($C_{52}H_{42}$), a solid hydrocarbon, somewhat similar to cholesterilin. It is derived from cholesterin by the action of concentrated phosphoric acid. It crystallises in beautiful prisms or silky needles. Cholesteron and cholesterilin have the same chemical composition, containing the elements of cholesterin less two equivalents of water.

$$\underbrace{C_{52}H_{44}O_2}_{\text{Cholesterin.}} = \underbrace{C_{52}H_{42}}_{\text{Cholesteron.}} + 2HO$$

(Cholesterilin.)

CHOLESTROPHANE. [CAFFEINE.]

CHO'LIAMBIC, the name of a kind of verse employed by Greek and occasionally by Latin writers (*e. g.*, Martial). It consisted of six feet, and was regulated by the same general laws as the iambic verse of tragedy. In two or three points it differed considerably: the fifth foot was properly and generally an iambus, though a few instances are found of a spondee in its place: the sixth foot was always a spondee or trochee. From this circumstance the name

Choliambus (χωλιαμβὸς) is derived, which means lame iambus; the metre limps, as it were, in the sixth foot. Anapæsts appear in the first foot, but in no other. Hipponax was one of the earliest writers in choliambic verse, and has therefore been called the inventor of it. The fragments of his poetry have been collected by Prof. Welcker. Simonides and Callimachus also wrote in this metre, and a few specimens from the latter poet remain. The age succeeding the death of Alexander contained many choliambic writers, who employed the same antiquated dialect that they found in the compositions of Hipponax and others. The fable-writer, Babrius [BABRIUS, BIOG. DIV.], who lived a little before the Augustan age, revived the choliambic poetry, and influenced probably by preceding poets, who had adopted the same metre, he appears not to have considered himself bound by the custom of his own age in the choice of words. ('Philological Museum,' vol. i.)

CHOLIC ACID ($C_{52}H_{43}NO_{12}$), (*Glycocholic acid; Glycocholalic acid*). Cholate of soda forms the principal portion of ox-bile. The cholic acid may be isolated and separated from the other biliary matters in the following manner: Bile is evaporated to dryness, and dried at a temperature of 250° Fahr. The residue is digested in cold absolute alcohol, the solution filtered, and ether added, which causes the separation of a brown resin, after which crystalline tufts are gradually deposited. These must be washed with absolute alcohol containing 10 per cent. of ether, dried *in vacuo*, redissolved in water, and dilute sulphuric acid added. The solution slowly deposits crystals of cholic acid, which may be further purified by another crystallisation from water.

Cholic acid forms white acicular crystals; they are slightly soluble in cold water, rather more so in boiling water. The solution has at once a bitter and a sweet taste, and an acid action on litmus paper. This acid is soluble in alcohol, less so in ether.

When treated with alkalies, cholic acid is converted into cholalic acid and *glycocin* (sugar of gelatin):

$$\underbrace{C_{52}H_{43}NO_{12}}_{\text{Cholic acid.}} + 2HO = \underbrace{C_{48}H_{40}O_{10}}_{\text{Cholalic ocid.}} + \underbrace{C_4H_5NO_4}_{\text{Glycocin.}}$$

Boiled with sulphuric or hydrochloric acids, cholic acid yields, first, *cholonic acid*; then, *glycocin* and *choloidic acid*; and finally, *dyslysin*.

Cholic acid combines with bases to form salts, some of which are crystalline. With sugar and sulphuric acid it gives a purple colouration.

CHOLÖIDANIC ACID ($C_{32}H_{24}O_{14}$?), one of the products obtained by oxidising bile with nitric acid. It is most advantageously prepared by boiling cholöidic acid in a retort with moderately strong nitric acid till no more red fumes are evolved. On cooling, a mass of crystals of cholöidanic acid separate out, which may be purified by pressure to remove excess of nitric acid, and by recrystallisation from boiling water. They present the appearance of asbestos, are almost insoluble in cold water, slightly so in hot water, and very soluble in alcohol.

Cholöidanic acid unites with bases, but the salts are with difficulty obtained in a pure state.

CHOLÖIDIC ACID ($C_{48}H_{38}O_8$?). Formed by boiling cholic acid, choleic acid, or cholalic acid, with hydrochloric acid for three or four hours. On the cooling of the solution, it separates out as a solid mass, which may be purified by washing with water, solution in alcohol, and evaporating to dryness.

Cholöidic acid is a white solid, insoluble in water, soluble in alcohol, and slightly so in ether.

It decomposes carbonates with effervescence, but the salts which it forms are uncrystallisable.

CHOLONIC ACID ($C_{52}H_{41}NO_{10}$), the body that is first formed on boiling cholic acid with strong hydrochloric or sulphuric acids:

$$\underbrace{C_{52}H_{43}NO_{12}}_{\text{Cholic acid.}} = 2HO + \underbrace{C_{52}H_{41}NO_{10}}_{\text{Cholonic acid.}}$$

It separates out in oily drops that solidify on cooling. It may be purified by treating with caustic baryta, decomposing the resulting salt with hydrochloric acid, and crystallising from alcohol. It forms brilliant needles.

Cholonic acid forms soluble salts with the alkalies. The soda compound is crystalline. With the alkaline earths it forms insoluble combinations.

The relation which the above-mentioned acids bear to each other, and to bile, will be at once seen by a glance at the following table:—

		Products by Alkalies.	Products by Acids.	Products by Oxidation.
Bile from the ox.	Choleic acid.	Cholalic acid. Taurin.	Choloidic acid. Dyslysin.	Cholacrol. Nitrocholic acid. Choloidanic acid. Cholesteric acid.
	Cholic acid.	Cholalic acid. Glycocin.	Cholonic acid. Choloidic. Dyslysin.	Cholacrol. Nitrocholic acid. Choloidanic acid. Cholesteric acid.
	Cholesterin.	. . . . .	Cholesterilin. Cholesteron.	Cholesteric acid.

These acids are principally combined with soda, forming a species of soap.

The reactions with sugar and sulphuric acid, mentioned under CHOLEIC and CHOLIC ACIDS, has been taken advantage of by Pettenkofer as a means of testing for the presence of bile in organic matters. It is best applied as follows: An extract, obtained by digesting the substance in alcohol and evaporating to dryness, is dissolved in a little water, a few grains of sugar added, and pure sulphuric acid cautiously poured in. A red colour ensues, changing to purple and violet if bile is present. [See also BILE, NAT. HIST. DIV.]

CHONDRIN. A kind of gelatine from which it differs in being coagulated by vegetable acids. It is obtained by boiling the cornea of the eye with water.

CHORA'GUS, the name of a public officer at Athens. Each phyle, or tribe, had a choragus (χορηγὸς), who was obliged to provide a chorus to perform at the representations in the theatres, and at many religious solemnities. The office was probably rotatory, though none but rich persons able to bear the expenditure without inconvenience could be forced to take it. (Fred. Aug. Wolf, 'Prolegomena in Demosth. Orat. Leptin.' p. lxxxvii.) The choragus had entire charge of the whole choral apparatus: he paid for the dresses and the crowns, and all other decorations. He also provided and paid a teacher (χοροδιδάσκαλος, chorus-teacher), who instructed and trained the choristers in the arts and graces of their profession. Every expense of whatever kind attendant on the equipment of a chorus, either in the theatre or in any other exhibition, was discharged by the choragus. The tribes vied with one another in the splendour of their exhibitions, and especially in the sumptuousness of the choral ornaments: sometimes the expenses incurred by the state were so heavy, that both the treasury and the resources of individuals were exhausted. (See also 'Xen. Hipparch.' i. 26.) In some cases the choragus seems to have led the chorus in person, as well as to have defrayed the expenses; and once a choragus acted as flute-player at Sparta. (Müller, 'Dorians,' vol. ii., p. 341.) The term choragus included sometimes the gymnasiarch and the hestiator. (Fred. Aug. Wolf, in 'Demosth. Leptin. Orat. Comment.' 16, 24.) The former of these had charge of the athletic exercises of the youth; and the latter was obliged to give a banquet to his tribe on occasion of any great holiday or festival: these offices were similar in kind to that of the choragus, which probably from being the most expensive and important of the three, stands frequently for the whole. The choragus is not to be confounded with the choropoios (χοροποιὸς), who was general chorus-manager to all the tribes. (Xenoph. 'Ages,' ii. 17; Müller, 'Dorians,' vol. ii., p. 341, n.) Some age appears to have been fixed below which it was not competent to a man to be made choragus: a choragus of boys could not be under forty years of age; the age required in other cases is not known. A resident alien or metic (μέτοικος) could not hold the office. Demosthenes was on one occasion a volunteer choragus, and was grievously insulted during his term of office by Meidias. (Demosth. 'Against Meidias.') A tripod was the common prize of the successful choragus, who occasionally erected a small building on which he placed the prize. Such is the beautiful choragic monument of Lysicrates (erected about 334 B.C.) at Athens, vulgarly called the Lantern of Demosthenes. These monuments were erected in the vicinity of the theatre, or in the street on the eastern side of the Acropolis, which led from the Prytaneium to the sacred enclosure of Dionysus—hence called the "street of the tripods."

CHORD (in mathematics), a straight line drawn from one point to another of a curve. [ARC.] The term chord was also used in trigonometry, with sine, cosine, &c., to denote the chord of a circle, in which case it was also called the chord of the subtending angle. But this term, not being wanted, has not passed into pure algebra with sine, cosine, &c. [CIRCLE], so that when used, it must be considered as retaining its primitive sense, namely, that of a straight line, not an abstract number expressing the ratio of a straight line to the radius. To find the chord of a given angle, multiply the diameter by the sine of half the angle. Thus the angle being 23° 20′, and its half 11° 40′, take the sine of the half, which is ·2022176. If the diameter be 100 feet, then the chord of 23° 20′ is 20·22176, or 20¼ feet nearly.

To find the chord of a given arc, find the angle subtending the given arc [ANGLE], and proceed as before. The following Table of Chords, to every degree up to 180°, will frequently be useful in rough calculations. The diameter is throughout 10,000, to avoid decimals.

TABLE OF CHORDS (DIAMETER 10,000).

Angle.	Chord.	Angle.	Chord.	Angle.	Chord.	Angle.	Chord.
1 . .	87	11 . .	958	21 . .	1822	31 . .	2672
2 . .	175	12 . .	1045	22 . .	1908	32 . .	2756
3 . .	262	13 . .	1132	23 . .	1994	33 . .	2840
4 . .	349	14 . .	1219	24 . .	2079	34 . .	2924
5 . .	436	15 . .	1305	25 . .	2164	35 . .	3007
6 . .	523	16 . .	1392	26 . .	2250	36 . .	3090
7 . .	610	17 . .	1478	27 . .	2334	37 . .	3173
8 . .	698	18 . .	1564	28 . .	2419	38 . .	3256
9 . .	785	19 . .	1650	29 . .	2504	39 . .	3338
10 . .	872	20 . .	1736	30 . .	2588	40 . .	3420

Angle.	Chord.	Angle.	Chord.	Angle.	Chord.	Angle.	Chord.
41	3502	76	6157	111	8241	146	9563
42	3584	77	6225	112	8290	147	9588
43	3665	78	6293	113	8339	148	9613
44	3746	79	6361	114	8387	149	9636
45	3287	80	6428	115	8434	150	9659
46	3907			116	8480		
47	3987	81	6494	117	8526	151	9681
48	4067	82	6561	118	8572	152	9703
49	4147	83	6626	119	8616	153	9724
50	4226	84	6691	120	8660	154	9744
		85	6756			155	9763
51	4305	86	6820	121	8704	156	9781
52	4384	87	6884	122	8746	157	9799
53	4462	88	6947	123	8788	158	9816
54	4540	89	7009	124	8829	159	9833
55	4617	90	7071	125	8870	160	9848
56	4695			126	8910		
57	4772	91	7133	127	8949	161	9863
58	4848	92	7193	128	8988	162	9877
59	4924	93	7254	129	9026	163	9890
60	5000	94	7314	130	9063	164	9903
		95	7373			165	9914
61	5075	96	7431	131	9100	166	9925
62	5150	97	7490	132	9135	167	9936
63	5225	98	7547	133	9171	168	9945
64	5299	99	7604	134	9205	169	9954
65	5373	100	7660	135	9239	170	9962
66	5446			136	9272		
67	5519	101	7716	137	9304	171	9969
68	5592	102	7771	138	9336	172	9976
69	5664	103	7826	139	9367	173	9981
70	5736	104	7880	140	9397	174	9986
		105	7934			175	9990
71	5807	106	7986	141	9426	176	9994
72	5878	107	8039	142	9455	177	9997
73	5948	108	8090	143	9483	178	9998
74	6018	109	8141	144	9511	179	9999
75	6088	110	8192	145	9537	180	10000

To use this Table, roughly, take out the chord of the nearest degree, multiply by the diameter, and divide by 10,000. Thus for a diameter of 2 feet, and an angle of 10° (supposing decimals are to be avoided), take out 872 opposite to 10°, and multiply by 2, giving 1744, which in inches is 20,928, which divided by 10,000, gives 2 inches, and 1-10th of an inch, very nearly.

An easy method of verifying the preceding table (if a doubt arise in any case) is contained in the following relations, which apply according as x is greater or less than 120°.

$$\text{ch. of } (x - 120°) + \text{ch. } (240° - x) = \text{ch. } x.$$
$$\text{ch. of } (120 + x) - \text{ch. } (120° - x) = \text{ch. } x.$$
$$\text{ch. of } (180° + x) = \text{ch. of } (180° - x)$$

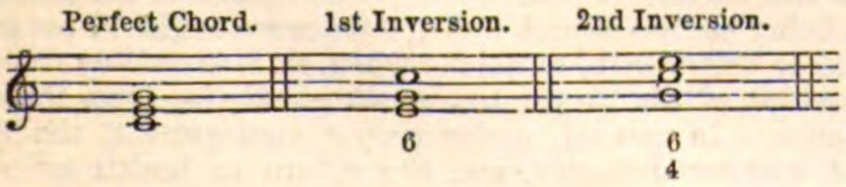
For instance, the chord of 130° is made up of those of 10° and 110°; the chord of 50° is the difference between those of 170° and 70°. These will be true within a unit, if the Table be correct.

CHORD, in music, is the harmonious combination of three or more musical sounds.

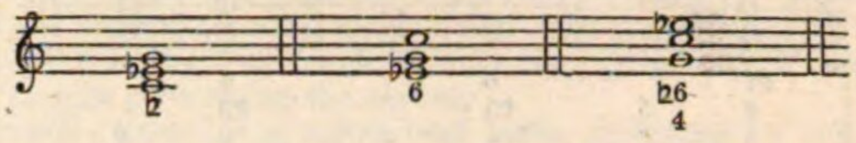
To account for the origin of chords, many theories have been proposed, the principal whereof are, that of Rameau—which D'Alembert endeavoured to elucidate, and Marpurg partly built his system on—and those of Tartini and Kirnberger. These theories, in the main, all arise out of, or finally resolve into, the natural harmonics of a distended string. But it will be proper here to state that Sir John Herschel, in his treatise on Sound, contained in the 'Encyclopædia Metropolitana,' declares "the insufficiency of any attempt to establish the whole theory of harmony and music on the aliquot subdivision of a musical string." Nevertheless, the facts that result from the simple division of a stretched string agreeing with the natural harmonic divisions of a sonorous tube—the French horn, for instance—and which cannot be disputed—are sufficient to prove that the foundation of what is properly called harmony was not arbitrarily laid. These facts may thus be briefly stated: the whole string gives, of course, the gravest, or generating, sound; four-fifths of the string give the major 3rd; two-thirds give the perfect 5th; and one-half gives the octave. Thus is produced the perfect or common chord, or triad, which, together with the chord of the seventh, is the source of all other real chords.

The Perfect Chord consists of any given note, together with a major 3rd and perfect 5th, which sounds may be represented by the letters C, E, G, or by the syllables *do, mi, sol.* It has two inversions, or derivatives: the first is made by taking the E (*mi*) as the base, producing the chord of the *sixth;* the second, by taking the G (*sol*) as the base, producing the chord of the *sixth* and *fourth.* Example:—

Perfect Chord. 1st Inversion. 2nd Inversion.

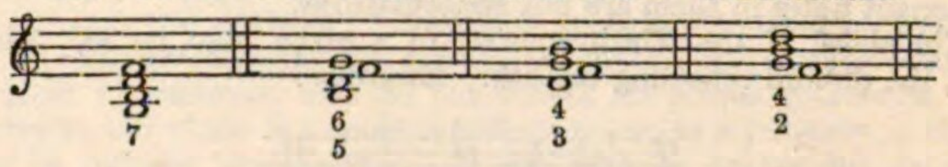


This chord is denominated the Perfect Minor Chord when its 3rd is flattened; and, so altered, its inversions are affected accordingly. Example:—



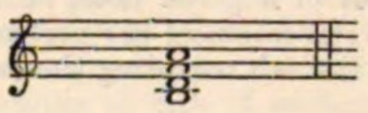
The chord of the seventh—called the Dominant Seventh—is formed by adding to the perfect chord a minor 7th, and consists of a given note, together with a major 3rd, a perfect 5th, and a minor 7th. It may be represented by the letters G, B, D, F, or by the syllables *sol, si, re, fa.* This has three inversions: the first is made by taking the B (*si*) as the base, producing the chord of the *sixth* and *fifth;* the second, by taking the D (*re*) as the base, producing the chord of the *fourth* and *third;* the third, by taking F (*fa*) as the base, producing the chord of the *fourth* and *second.* Example:

Chord of 7th. 1st Inversion. 2nd Inversion. 3rd Inversion.



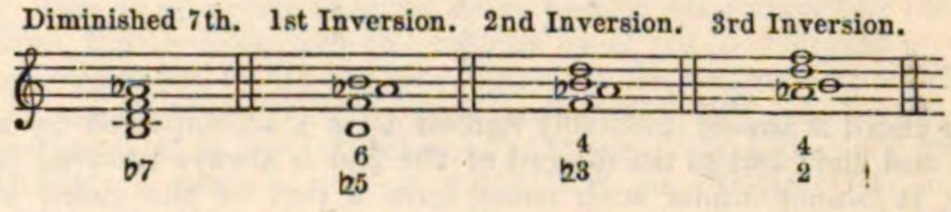
The Perfect Chord, and its inversions, are called consonant chords all other chords, and their inversions, are called dissonant chords.

The chord of the Imperfect, or Minor, Seventh, consists of a given note, a minor 3rd, an imperfect 5th, and a 7th. Example:—

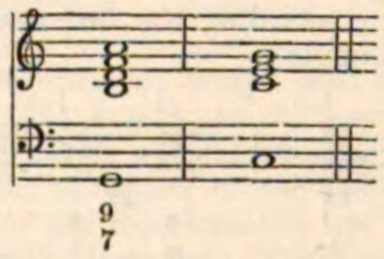


The chord of the Diminished Seventh—sometimes called the Equivocal Chord—consists of a given note, its minor 3rd, imperfect 5th, and diminished 7th. Example:—

Diminished 7th. 1st Inversion. 2nd Inversion. 3rd Inversion.

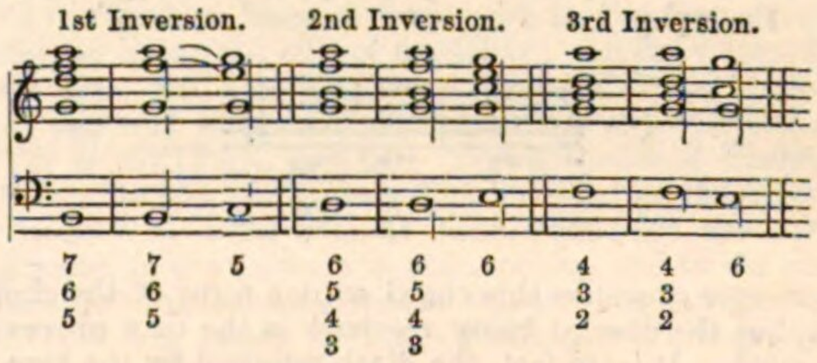


The chord of the Dominant Ninth consists of a given note, its major 3rd, 5th, 7th and 9th. Example:—

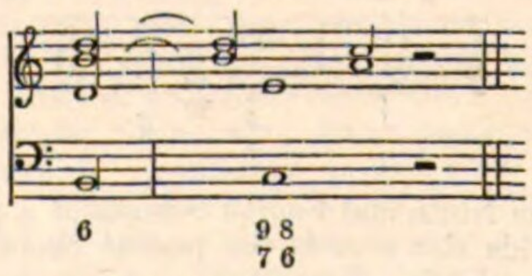


This chord has three inversions, though they are not in very common use. M. Catel gives them in the following manner:

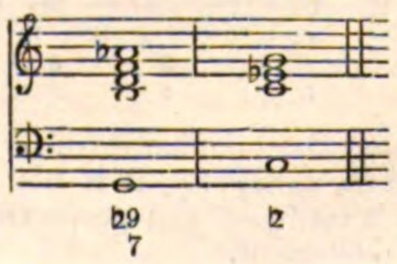
1st Inversion. 2nd Inversion. 3rd Inversion.



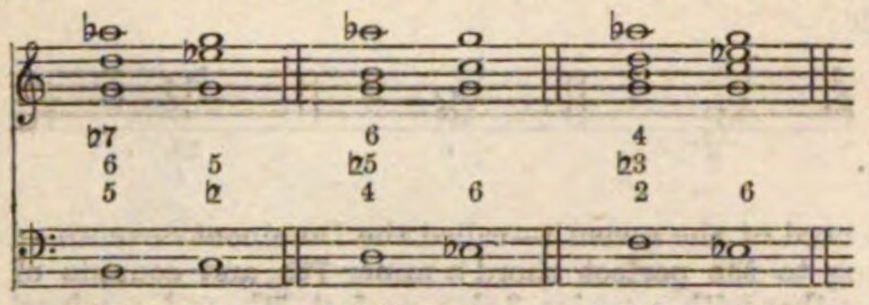
But by far the most elegant form which the chord of the Ninth and Seventh assumes is a retardation of the 8th and 6th. Example:—



The Dominant Minor Ninth consists of the same sounds as the Dominant Ninth, but the 9th is flat. Example:—



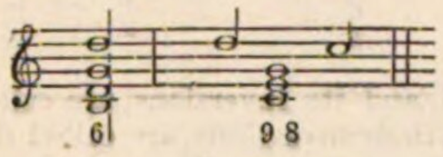
This has three inversions, which also we extract from M. Catel's treatise :—



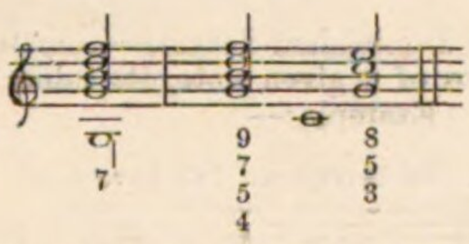
1st Inversion. 2nd Inversion. 3rd Inversion.

We have seen, that by adding to the Perfect Chord a 3rd above its 5th, the chord of the Seventh is formed : by the further addition of thirds, theorists form other chords, sometimes called *chords by supposition*. These are, the chord of the Ninth, of the Eleventh, and of the Thirteenth. The last three chords, as well as others presently to be mentioned, are merely chords of retardation : or, in other words, the dissonant notes in them are but appoggiaturas.

The chord of the Ninth consists of a given note, its 3rd, 5th, and 9th, the discord retarding the 8th. Example :—

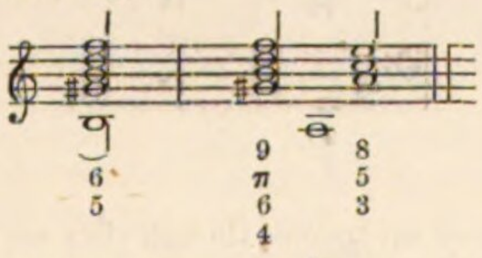


The chord of the Eleventh (more commonly called the chord of the Sharp Seventh), consists of a given note, its 4th (or 11th), 5th, major 7th, and 9th. It is a retardation of the perfect chord, the 9th and 7th retarding the 8th, and the 4th retarding the 3rd, of the perfect chord. Example :—

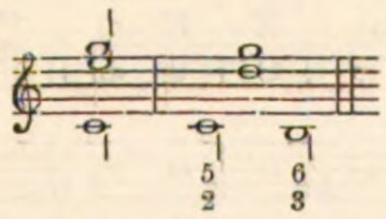


This chord is almost invariably figured by a ♯, accompanied by a 5th, 4th, and 2nd; but as the discord of the 2nd is always resolved in the base, it cannot, under such name, form a part of the chord of the eleventh.

The chord of the Thirteenth consists of a given note, its 4th, 6th (or 13th), major 7th, and 9th. This is a retardation of the perfect minor chord, the 4th and 6th retarding the 3rd and 5th, the 7th and 9th retarding the 8th. Example :

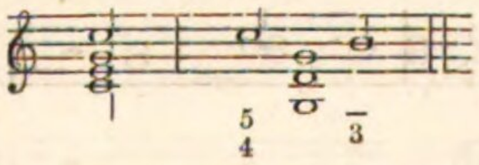


The chord of the Fifth and Second consists of a given note, its 2nd and 5th. Example :

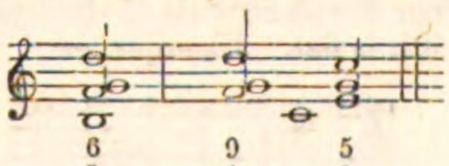


Albrechstberger considers this chord as one form of the chord of the Eleventh, but the discord being resolved in the base proves it to be a 2nd, not a 9th. It is, in fact, the Sixth retarded by the base.

The chord of the Fifth and Fourth consists of a given note, its 4th and 5th, and retards the perfect chord, the 4th retarding the 3rd. Example :—



The chord of the Ninth and Fourth consists of a given note, its 4th, 5th, and 9th. This also retards the perfect chord, the 4th and 9th retarding the 3rd and 8th. Example :—



We will only add that the nomenclature of chords stands much in need of correction; but, unhappily, it is not the only branch of the theory of music that is confused and perplexing, from want of logical accuracy and lucid arrangement.

CHOREA (remotely from the Greek *χορεία*, and immediately from the Latin *chorea*, a dance with singing—Chorea Sancti Viti—Saint Vitus's Dance), a disease affecting with irregular movements the muscles of voluntary motion, these muscles being no longer under the command of the will, and the power both of walking and of using the arms and hands being impaired. The chief external manifestations of this disease are in the muscles of voluntary motion; but its real seat is in certain internal organs, frequently in those which belong to the apparatus of digestion. If the history of any case of chorea be carefully examined from the commencement, it will be found that the more manifest disorder has been preceded by deranged appetite, which is sometimes voracious, and at other times altogether lost; by constipated bowels, and by imperfect digestion. There is at the same time a remarkable failure of the general physical strength. The derangement in these organic functions is always accompanied with a greater or less degree of mental disorder. The mind is irritable and fretful, and oftentimes reserved, gloomy, and desirous of solitude. After this state of physical and mental disorder has continued some time, and the languor, lassitude, and general weakness of the system have proportionally increased, there come on irregular and involuntary twitchings of the muscles, particularly the muscles of the face, which at first are thought by the friends of the patient to be merely the effect of imitation. But these convulsive motions progressively increase, until the muscles of the extremities, face, lower jaw, head, and trunk, all become agitated with violent and irregular movements. In this case the patient is incapable of walking steadily, his gait is jumping or starting; sometimes he is altogether unable to walk, and seems palsied, while he is equally unable to perform the ordinary motions with the affected arm.

A century and a half ago Sydenham gave the following graphic and correct description of the convulsive motions characteristic of this disease when fully formed. "First it shows itself by a lameness or rather instability of one of the legs, which the patient drags after him like a fool. Afterwards it appears in the hand of the same side, which he that is affected with the disease can by no means keep in the same posture for one moment; if it be brought to the breast or any other part, it will be distorted to another position or place by a convulsion, let the patient do what he can. If a cup of drink be put into his hand he represents a thousand gestures, like jugglers, before he brings it to his mouth; for whereas he cannot carry it to his mouth in a right line, his hand being drawn hither and thither by the convulsion; he turns it often about for some time, till at length, happily reaching his lips, he flings it suddenly into his mouth, and drinks it greedily, as if designing only to make sport."

As the disease advances the power of distinct articulation is lost: even the deglutition becomes difficult, in some cases, to such a degree that fluids are forcibly thrown up from the pharynx in attempts at swallowing them; the eyes lose their lustre; the complexion becomes pallid and muddy; the expression of the countenance languid and vacant; and in the severest cases the mouth is variously twisted and the saliva drivels from it; the tongue is protruded irregularly and spasmodically; the eyes are distorted and rolled in various directions, and the sight is occasionally defective. The muscles meantime become soft and flaccid; emaciation takes place; the pulse is weak, but not much quickened; the urine is pale and copious, and the bowels are always constipated.

The mind, irritable from the commencement, is now harassed by painful images and incongruous ideas, which every effort is made to conceal, and various desires and emotions are produced, sometimes without apparent cause. This disordered condition of the mind, when the disease is severe and long-continued, ultimately terminates in a state of fatuity, of which the pallid, listless, and vacant countenance is the external sign and expression.

This disease is common to both sexes, but it is much more frequent in the female than in the male, in the proportion of about three of the former to one of the latter. It seldom attacks before the 8th, nor after the 15th or 16th, year of age, although no period of life is wholly exempt from it. The different muscles that are affected, and the different degrees in which they are agitated by the irregular motions, give an endless diversity to the external appearance of different cases; for the convulsive motions are sometimes slight, at other times severe, sometimes partial, at other times general; but most commonly they are partial, and sometimes they are strictly confined to one side. The duration of the disease may vary from a few weeks to many months.

Chorea is often associated with other affections more or less closely allied to it in nature, and alternates with them. In the female it is often observed in connexion with chlorosis, with the suppression of the catamenial discharge, and with hysteria, and in the male with rheumatism, paralysis, and dropsy. Occasionally it terminates in epilepsy, paralysis, dropsy, particularly hydrocephalus, and, as has been stated, complete idiotcy. Cases are on record in which it has terminated in violent convulsions, and inflammation of the brain, followed by coma and death. It often accompanies disease of the heart.

Such being the occasional issue, the disease ought in no case to be neglected or trifled with, especially when, as is invariably the case, the postponement of the proper treatment greatly increases the difficulty of the cure. In general, under proper management, the disease is removed without difficulty, and the return to health is commonly

complete, although this is one of the affections which is peculiarly subject to relapse. It is not at all uncommon for the patient, when apparently cured, to be attacked several times in succession either with the same disease or with some one of the affections into which it has been stated to have so great a tendency to lapse. Still however those relapses are curable by persevering in the proper treatment, and it is remarkable that even when paralysis and idiotcy appear to be fully established they yield far more readily to appropriate remedies than when those affections have been induced by a primary affection of the brain.

Chorea arises in widely different states of the system, and is produced by different causes, and therefore in different cases requires a different treatment. In many cases it arises from an accumulation of irritating matter in the alimentary canal, which must be removed by a course of purgative medicines. The choice of the purgative and the duration of the course must depend on the state of the system in each particular case; but in general the purgative must be of an active nature, and the course decided and long continued. At the same time the strict regulation of the diet, both as to the quality and the quantity of the food, is indispensable. As this malady almost invariably occurs in an enfeebled state of the constitution, active exercise in fresh and pure air, and the administration of the preparations of iron are to be recommended.

When this affection is connected, as it occasionally is, with organic disease of the spinal cord or brain, it is of the last importance to the proper treatment of the case that this organic lesion should be discriminated, and that the remedies proper to it should be promptly applied. From what has been stated it will appear that this is one of the diseases which should engage the anxious attention of parents, teachers, and all who have the charge of young persons of either sex. Not only the health or disease of puberty and adolescence, but the health or disease, physical and mental, of mature age, may depend on their prompt attention to, or neglect of, the very first symptoms of this malady.

CHORUS, among the Greeks, was a number of persons, male or female, who sang melodies accompanied with dancing. The chorus appears to have been of Doric origin, and the Doric dialect continued to be chiefly used, even in the choral songs of Attic tragedies. (Müller, 'Dorians,' vol. ii, p. 381.) Originally the choral performance was a separate exhibition, and was of a religious character: hymns were chanted in honour of Dionysus and other gods. Afterwards an actor was added by Thespis, who first introduced the dialogue; other changes were made by his successors, especially Phrynichus, till a second actor was added by Æschylus, who embodied the chorus in the constitution of the Greek drama, as a part and only a part of the representation. Many explanations of the object of the chorus have been offered by different writers. It would certainly give a very imperfect idea of its office, to say that it was only retained in order to give the other actors breathing-time, and to prevent a break in the performance. The chorus may be regarded rather as the representation of the aggregate body of spectators: the chorus generally gave utterance to those emotions of pleasure or sorrow which the audience might be supposed to feel. They sometimes took upon themselves to give instruction or to administer reproof.

The tragic chorus consisted at first of fifty, afterwards of fifteen persons; the comic chorus consisted of twenty-four. According to Julius Pollux ('Onomast.' iv. 15), the number of the tragic chorus was abridged after the performance of the Eumenides of Æschylus: the alarm caused by fifty of these ladies was too great. The chorus entered into the orchestra, and remained there performing their evolutions, and observing the thymele or altar, which was in the middle of the orchestra, as the centre of their movements. As they sang they moved in a dance, suited to the subject of their song, and modulated by the accompanying music; sometimes the movements of the dance were so appropriate as to convey to the spectators the full meaning of the chorus, independently of the words of the song. The perfection to which the Greeks carried their skill in affecting an audience by the harmonious union of dancing and music forms one of the main differences between the ancient and modern theatre. The songs of the chorus consisted of three parts, the strophe (or *turning*), the antistrophe (*opposite turning*), and the epode (*after-song*): during the first they turned from right to left, during the second from left to right, and during the third they stood still in front of the spectators. When they sang, they all sang; when they took part in the dialogue, one only, the coryphæus or leader of the chorus, spoke, from the top of the thymele; and hence in addresses to the chorus there is a constant change of number—*thou* and *ye*. (Schlegel, 'Theatre of the Greeks.') Frequently they divided into two sets, who, by means of their two leaders, carried on a separate dialogue, which generally revealed their sentiments on the progress of the plot, their fears, anxieties, and hopes. They also chanted hymns of supplication or thanksgiving to the gods.

The choruses at Athens did not perform exclusively in the theatre, but on many occasions when there was no scenic representation at all. At the Panathenæa and the Thargelia, and at the Gymnopædia of Sparta, choruses of men and boys sang. All choruses at Athens were provided, equipped, and instructed, by persons appointed by the several tribes. [CHORAGUS.]

CHORUS, in music, a composition sometimes in two or three, but generally in four parts, sung by many voices, accompanied by the whole band when performed in an orchestra or on the stage, but by the organ alone when sung in a choir. The chorus of the oratorio and opera has full instrumental accompaniments, but that of our cathedral services and anthems is written with only an organ accompaniment.

The term CHORUS is also applied in an aggregate sense to the whole body of singers performing the chorus.

A DOUBLE CHORUS is in eight vocal parts, and sung by two choirs. Many of Handel's choruses in 'Israel in Egypt,' in 'Solomon,' and in 'Deborah,' are of this kind.

CHOSE IN ACTION is a technical term in the law of England, denoting that kind of property of which the owner is not in the actual possession or occupation, though he has a legal right to obtain the possession. As this right can only, in general, be enforced by action, the property, whatever its nature, is termed a thing (*res*), or *chose* in *action*, in contradistinction from a thing or property in *possession*. Thus if I buy a quarter of wheat out of a large quantity, my interest in the wheat is a property to which I have a right. If the seller, in breach of his engagement, refuses to deliver it, I can only assert my right through the medium of an action or suit. As long as I have only the right of enforcing the delivery of the wheat, or recovering an equivalent in damages, and do not obtain the actual possession, my property in the wheat is a chose in action, being, as a property, a thing rather *in potentiâ* than *in esse*. In like manner money due upon a bond or a bill of exchange is a chose in action; and also the right to compensation for damage sustained by means of the breach of any kind of contract.

The policy of the English law, in discouraging all contracts tending to promote litigation, introduced a rule that property in action merely, and not in possession, could not be assigned or transferred to any third person. This rule has in modern times received considerable modification. In the familiar instance of bills of exchange, drafts on bankers (which are in law bills of exchange), and promissory notes (all which are strictly choses in action), an indorsement not only transfers to the indorsee the absolute right to the sum to be recovered, but also enables him to sue in the common law-courts upon the bill or note in his own name. Courts of equity in other cases protect assignments of choses in action; but in these cases the assignee must sue in the name of the original contractor, whom the law, regarding the assignment, which it does not sanction, as a nullity, treats as the party still entitled, if the assignee proceeds at law. (Blackstone's 'Comm.,' vol. i. pp, 403, 452.)

CHRISM, sometimes written CRISOME, or CHRISTOM, in its strict interpretation means "unction," from the Greek χρίσμα (chrisma), ointment; but is more generally received as the name for oil consecrated by the bishop, and used in the Romish and Greek churches in the administration of baptism, confirmation, ordination, and extreme unction: and is, or used to be, prepared on Holy Thursday with much ceremony. Ducange ('Glossar. ad Script. Med. et Infimæ Latinitatis,' edit. Francof. ad Mœn., 1681, tom. i., col. 973) says there are two kinds of chrism, the one prepared of oil and balsam, used in baptism, confirmation, and ordination, the other of oil alone, consecrated by the bishop, anciently used for the catechumens, and still used in extreme unction. (See also Durand's 'Rationale Divinorum Officiorum,' lib. vi., cap. 74, 84.) The word crisome is also found applied to the cloth which was laid over a child's face when baptised, to prevent the unguent from running off. (See the 'Liturgy' compiled in the 2nd year of Edward VI.) Children likewise who died in the first month were called Chrisomes in the old bills of mortality; and the white cloth was used as a shroud. Mrs. Quickly says of Falstaff ('Henry V.' ii, 3), "A made a finer end, and went away, an it had been any christom child."

CHRIST'S HOSPITAL, London. The hospitals of Christ, Bridewell, and Saint Thomas the Apostle, were founded by the same charter of king Edward VI., dated 26th of June, 1553; for the support of which he granted to the mayor and commonalty, and to the citizens of London, numerous possessions within the city of London, and the counties of Middlesex, Essex, Hertford, Buckingham, Cambridge, Kent, Derby, and York. Christ's Hospital was established upon the site of the house of Mendicants or Grey Friars, in Newgate Street, about five years after the king's grant; when about four hundred orphans were admitted, and clothed in russet, which was soon afterwards changed for the dress which they now wear, namely, a blue coat or tunic, reaching to the feet, with yellow stockings, and a round bonnet or cap. The institution has little or no income under the charter. It is apprehended that the estates which were given under it to the city of London were afterwards apportioned to the royal hospitals as the citizens thought fit. All its other estates can be traced to legacies and donations of different periods. At the suggestion of Sir Robert Clayton, then lord mayor, and a considerable benefactor, king Charles II, in 1676, granted a second charter, allowing 1000*l.* a year, for seven years, to establish a mathematical school for forty boys, and an annuity of 370*l.* 10*s.*, payable at the Exchequer, for the especial purpose of educating and placing out yearly ten boys in the sea-service. These boys remain in the hospital until they are thus provided for.

The greater part of this hospital was involved in the destructive fire of London in 1666; but by the zeal and liberality of the corporation of London, aided by donations, loans, and the operation of the revenues of the hospital, it soon revived, and was rebuilt under the able direction of Sir Christopher Wren. The buildings, however, having, to a certain

extent, fallen into decay, from their antiquity, and the funds of the charity being unequal to their entire restoration upon a plan of suitable uniformity and convenience, it was resolved, at a general court of the governors, on the 28th of January, 1803, to open a subscription for that purpose, when the corporation of London gave 1000*l.*; several of the city companies followed the example, and the donations for this purpose up to 1833, chiefly of individuals, amounted to 38,676*l.* The great work of rebuilding was commenced in 1825, under the direction of Mr. Shaw, by whom the magnificent hall, only second in size to that of Westminster, the grammar school, some of the dormitories, and the infirmary, were constructed. Since then other improvements have been made. In 1858 the site of the old Giltspur Street Compter was acquired, and formed into a play-ground; and in 1859 the entrances from Newgate Street were rendered ornamental.

The managing governors of the hospital are the mayor and commonalty of the city of London, represented by the lord mayor, aldermen, and twelve common council-men, who are chosen by the rest of the common council out of their own body, according to an Act of Parliament obtained in 1782, to settle the disputes between the city of London and the hospital. Besides the corporation, noblemen and gentlemen of all ranks are governors, who become benefactors to the amount of 400*l.* The number of governors of this kind is not limited. The right of presentation is vested in the governors in rotation, and in some of the officers by virtue of their offices. The children presented must be not less than seven nor more than ten years of age, and they come out at fifteen, except those boys who become Grecians, when they remain till they are eighteen or nineteen. Of these Grecians, there used to be six, increased in 1857 to eight, who are sent, with considerable endowments arising from the gift of the hospital itself, and from various scholarships founded by individuals, to the universities of Oxford and Cambridge.

In 1683 the governors erected a handsome building in the town of Hertford, for both boys and girls. The girls permanently remain here. All the boys are also sent to Hertford, and here they are nursed and instructed until they are rendered capable of receiving the more advanced education of the foundation in London. The establishment at Hertford, when full, contains upwards of 400.

The accommodation in the two establishments in London and at Hertford is for about 1200 boys, and at Hertford for 70 girls.

In London there are classical masters, writing masters, mathematical, drawing, and singing masters, with masters for French and German; and in most of the departments there are also assistant-masters or ushers. It should be observed, that the boys' school is essentially classical; Latin and Greek are taught to all as the fundamental principles of their education. Mathematics are also essential to King Charles's foundation, and to those students who aspire to be deputy Grecians or Grecians; but all may be taught if they apply. Drawing and the living foreign languages are modern improvements. The girls are only taught the common branches of education, and are instructed in matters of domestic economy, so as to fit them for household service. At Hertford there are a classical master, writing master, two ushers, and two mistresses to the girls' school; besides nurses, &c., at each.

The gross income of the charity averages about 50,000*l.* The expenses are kept somewhat below the income, and these accumulations allow for occasional extensions, as in the addition of two Grecians. The governors enjoy the patronage of several ecclesiastical benefices, most of them in the counties of Essex and Surrey.

CHRISTIAN KNOWLEDGE, SOCIETY FOR THE PROMOTION OF, is the oldest society in the kingdom established for the education and religious instruction of the poor. It is an incorporated society, and is supported by the members of the Church of England. Its founder may be considered to have been the Rev. Dr. Thomas Bray, who, with four others, held their first meeting on March 8, 1698-9, and it was incorporated in 1701. The chief objects pursued by Dr. Bray were the promotion of charity schools, the planting of the Episcopal Church in British colonies; the formation of lending libraries, and the furnishing of cheap books and depositories of books for poor clergymen and students for holy orders. With a vast development, these continue to be the objects to which the exertions of the society are directed. In the first year of its existence, industrial schools were projected, and parochial charity schools founded; there are now nearly 25,000 such schools, with nearly a million and a half of children taught in them. In 1701 the system of school inspection was instituted; and this was followed by the founding of training institutions for schoolmasters and schoolmistresses. The society continues to give assistance, chiefly by supplying books to schools founded for the gratuitous or cheap education of the poor on Church of England principles; and it was the instituter, and continues to be the supporter, of the annual assemblage of the charity children of the metropolis in the cathedral of St. Paul's.

In the colonies and dependencies of the British empire the expenditure of the society has been on a larger scale. It sent missionaries to India as early as 1749,—among them the celebrated Schwarz; it has promoted the establishment of all the colonial bishoprics, contributing upwards of 30,000*l.* towards their endowment; it has given above 90,000*l.* for building of colonial churches; and it has furnished between 40,000*l.* and 50,000*l.* to various colonial colleges and college-schools. But the chief field of the society's exertions has been the preparation and circulation of books and tracts; more especially of Bibles, Testaments, and Prayer Books. We have already mentioned [BIBLE SOCIETIES] its labours in that department. These works are supplied to the public at an average annual loss to the society of about 14,000*l.* The yearly issue is about 135,000 Bibles, 70,000 New Testaments, and 345,000 Prayer Books. From the year 1733, when the society first began to report its annual issues, nearly nine million Bibles and New Testaments have been distributed, and nearly eleven million Prayer Books. For purposes of Christian education, it also publishes largely both in the form of cheap tracts and of works possessing scientific and literary excellence and beauty of appearance. By these, though comparatively cheap, the society does not profess to lose, but the total issue is enormous. The annual average is about three millions and a half; and from 1733 to April, 1859, not less than one hundred and thirty-six millions of books and tracts have been sold.

The income of the society arises from subscriptions, donations, benefactions, and the sale of its books. Subscribers and donors have the privilege of purchasing the society's publications at a reduced rate. In the year ending April, 1859, the total receipts were 100,061*l.*, of which 61,848*l.* arose from the sale of works, and the remainder from the sources mentioned above. In the same year the expenditure was 100,062*l.*, of which 74,459*l.* were for the production of the various works sold, 6000*l.* were spent in various ways on the colonies, about 2000*l.* went for salaries and management, and the remainder in miscellaneous items. An East Indian missionary fund has been recently established, and is kept distinct by the society; but this has been included in the above statement.

CHRISTIANITY, that system of religion which has for its founder Jesus Christ.

The history of Christianity may be divided into three periods, of which the first embraces the life and ministry of Jesus Christ; the second comprehends the acts of the apostles after the death and resurrection of Christ, and the formation of the Christian church; the third period comprehends the history of the church from the termination of the labours of the apostles to the present day, and is a distinct subject from the history of the first two periods, so far as concerns the essential doctrines of Christianity.

The communities or churches founded by the apostles soon began to differ in various points of doctrine and discipline. From these differences arose a long series of violent disputes and animosities among the various religious parties or communities into which the whole body of Christians was divided. The frame of civil society also, in all the countries into which Christianity was gradually introduced, was necessarily affected by the new religion. Thus the history of the Christian church immediately subsequent to the cessation of the apostles' mission, and indeed we may say during the time of their mission, is inseparable from the history of all the several political societies among which Christianity was established. The history of Christianised Asia, Africa, and Europe, for several centuries, might with more propriety be called the history of the church in this or that country, than any thing else. The word church is here used in that proper and large sense which is pointed out at the end of the article CHURCH.

Viewing, however, the history of the church as a distinct subject, and paying no regard to the events of civil society, except so far as they are immediately and intimately connected with the church (the term here being used in a narrower sense), such a history is generally supposed to possess a sufficient unity of subject, as distinguished from civil history, to form a separate and distinct division of historical inquiry. Accordingly we have numerous histories of the church, whose professed object is to develop the progress of Christian doctrines, of the various opinions on matters of faith and discipline which have divided Christians, and of the various communities or associations into which Christians have been distributed. But these histories, in all ages, being mainly written by the clergy, are often not so much histories of the great body of Christians in this or that country, as of those whose immediate interests were often little identified with the interests of those whom it was their business to instruct. Such a contracted view of the history of Christianity, and of the history of the church in the several countries where Christianity is established, must always appear unsatisfactory to those who, considering the origin of the religion of Jesus Christ, its progress, and its development, as the great subject of the political drama of the civilised world for eighteen centuries, regard the history of *the* church or of *a* church, not as in any respect dissociated from civil history, but as a component part of it. Intimately blended with all the relations of life, with all the great events of political society, and now for at least fourteen centuries directing or influencing all the functions of government, and by turns assisting or retarding the progress of knowledge, according to the various forms in which it has been moulded for political purposes, a history of the church, distinct from the political history of the same nation and the same period, can have little value, except so far as it may be a good history of the clergy. Such a history of the church, however, has been often attempted by men neither deficient in industry nor learning; but the one-sided view which they have taken has never satisfied careful inquirers, and has only had the effect of forming in the minds of those who read much and think little, a certain confused notion of some essential difference between the history of the church and the history of those who, in various ages,

have composed that church. On the other hand, writers of what is called history in the usual acceptation of the term, often seem to consider the history of the church as hardly lying within their sphere. It is true that those great events in the history of the church which have changed the face of society are not and cannot be overlooked by such writers; but the influence of the slow and incessant working of the great principle of Christianity, which is intimately blended with all the social systems of all the countries where Christianity is established, and by its all-pervading power penetrates to their remotest and minutest members, and enters into all the recesses of domestic life, is rarely glanced at, and seldom, if ever, duly estimated by writers of history. The history of civilisation, which is the history of a continued progress, would appear to every reflecting person inseparable from the history of Christianity, or, in other words, of the Church, taking this word in its large and proper sense. The public acts of the clergy as a body receive a place among other public events in our annals and our histories; but as the real history of a people is generally sunk in the history of their rulers, so that of the true church is merged in the history of the clergy.

A history, then, called a history of *the* church, in the sense in which we believe all writers of general church history have understood the term, appears to be a division of history which ought either to be entitled a History of the Clergy and of their Acts and Opinions, or it ought so to be blended with general civil history as to render a separate name unnecessary.

Instead of attempting a history of the church in any sense, we have treated of the characteristic doctrines and discipline of the various bodies of Christians, whether properly called churches, or improperly so called, under their several heads. [BAPTISTS; CHURCH; CATHOLIC CHURCH, ROMAN, &c.]

Christianity is at present diffused over a large part of the world; but it can only be said to be established, either by the authority of the state, or by general consent, in the following countries. Christianity is established in all parts of Europe except the Ottoman dominions. In America, it is established in all those countries which are now under the dominion of descendants of Europeans, which are, in fact, the largest and best parts of the continent. In Africa, it exists in Abyssinia in a very corrupt state, and among the Copts of Egypt, who are now very inconsiderable in numbers. In Asia, the Christian religion is established in Armenia, but the number of Armenian Christians must not be estimated by the population of the country, for the merchants of this active and industrious people are found in many parts of Europe and Asia. In Syria, a branch of the Greek church still exists in the mountains of Libanus and the island of Cyprus; another in part of Syria and Diarbekr; and the Nestorians, who also belong to the Greek church, are found in Asiatic Turkey, about Mosul on the Tigris, in Persia, and also in some parts of India under the name of Christians of St. Thomas. In China and Japan Christianity at one time had made considerable progress, but in both was extinguished by a most unsparing persecution. In all the foreign dependencies of European powers, and especially those of the British empire, Christianity may be considered as established; though in many cases, as, for instance, in the British possessions in India, the number of Christians is small, when compared with the natives. But the zealous and persevering labours of European and American missionaries are now diffusing a knowledge of Christianity, and with it, of the useful arts of life, over countries hardly accessible to commercial enterprise; and it may safely be predicted that, by their efforts, and the spirit of colonisation which distinguishes some of the European nations, Christianity will rapidly spread itself over a much larger part of the habitable globe. The two other religions which occupy so large a portion of the earth's surface, Mohammedanism and Buddhism, are limited as to the sphere within which they can extend their doctrines, and it seems unlikely that they will pass the limits within which they are now confined. But Christianity being the religion of the most enterprising part of the human race, of those whose life consists in action more than in tranquillity and repose, is in a state of continual progress and diffusion; and it is probably to this difference between the temperament of most of the nations of Europe (a difference in some degree dependent on climate and local circumstances), and those of Asia and Africa, that Christianity still languishes among its comparatively few native professors in Asia and Africa, while the zeal and superior activity of the European race animate the missionaries of England and of the United States to preach the doctrines of Christianity in the very place of its birth, and to rival the old Catholic missionaries in zeal and courage. As the Apostles and the martyrs of the church testified the sincerity of their faith by their willingness to undergo every kind of suffering, and even death; so, in our own days, the apostles of Christianity, penetrating among the most uncivilised and savage tribes of the earth, have exhibited examples of courage, perseverance, and self-devotion unparalleled in the history of man.

In Africa, Christianity has hitherto made the least progress: and indeed wherever the Mohammedans have settled in that country, it has gradually decayed or disappeared. The Christian churches of the south coasts of the Mediterranean, which were established at an early period in the history of the church, no longer exist; those of Asia Minor have disappeared, and in Syria and Palestine, the cradle of Christianity, it still maintains a feeble and uncertain existence.

The great Christian churches are—

1. The Greek, or Eastern Church, divided into four principal branches.
2. The Latin, or Western, or Roman Catholic Church, which is single and undivided.
3. The Protestant Church.

The Protestant cannot be called a Church in the sense in which the Roman Catholic is called a Church, as it is not one undivided community, but consists of numerous independent communities. Still, as distinguished from the Roman Catholic community, the whole body of Protestants is sometimes designated, though improperly, as the Protestant Church.

CHRISTMAS, the festival in memory of Christ's nativity, the day of which is observed on the 25th of December. St. Chrysostom informs us that, in the primitive times, Christmas and Epiphany were celebrated at one and the same feast ('Homil. in Diem Nativ. D. N. J. Christi,' Opera, edit. Montfaucon, tom. iii.), probably from the belief that the rising of the star in the east and the birth of Christ were simultaneous. The separation took place at the Council of Nice, A.D. 325. The Armenians, however, continued to make but one feast of the two, as late as the 13th century.

The learned have long been divided upon the precise day of the Nativity. Some have fixed it at the Passover; others, among whom was archbishop Usher, at the feast of Tabernacles; and it has been observed, that if the shepherds were watching their flocks when it occurred in the field by night, it could hardly have happened in the depth of winter. Be this as it may, the 25th of December has been the day most generally fixed upon from the earliest ages of the Church. Sir Isaac Newton, in his 'Commentary on the Prophecies of Daniel' (Pt. i. c. ii. p. 144), has a chapter, 'Of the Times of the Birth and Passion of our Saviour,' in which he accounts for the choice of the 25th of December, the winter solstice, by showing that not only the feast of the Nativity, but most others, were originally fixed at cardinal points of the year; and that the first Christian calendars having been so arranged by mathematicians at pleasure, without any ground in tradition, the Christians afterwards took up with what they found in the calendars: so long as a fixed time of commemoration was solemnly appointed, they were content. The reader who would know more on this subject may consult Baronii, 'Apparatus ad Annales Ecclesiasticos,' fol. Lucæ, 1740, p. 475, et seq.; Bingham's 'Antiquities of the Christian Church,' lib. xx. cap. 4; and a curious tract entitled, 'The Feast of Feasts; or, the Celebration of the Sacred Nativity of our blessed Lord and Saviour Jesus Christ; grounded upon the Scriptures, and confirmed by the practice of the Christian Church in all ages.' 4to, Oxf. 1644.

The season of the Nativity is no longer marked by that fervid hospitality which characterised its observance among our forefathers. At present, Christmas meetings are chiefly confined to family parties. The wassail-bowl, the yule-clog, and the lord of misrule, with a long train of sports and customs which formerly prevailed at this season, are forgotten: even Christmas carols are nearly gone by; and the decking of churches, and occasionally of houses, with holly and other evergreens, forms now almost the only indication that this great festival is at hand. For the customs formerly prevalent before, at, and about Christmas, see Brand's 'Pop. Antiq.,' edited by Sir Henry Ellis, vol. i.

CHROMATES. [CHROMIUM, *Chromic Acid.*]

CHROMATIC. [ACHROMATIC; LIGHT.]

CHROMATIC SCALE, in music, is the scale of semitones [SCALE]; and by *chromatic music* is commonly signified that kind of harmony in which extreme intervals are much used.

In the Greek music the *chromatic* (from χρῶμα, *colour*) was the second of the three *genera*, and, according to the opinion of some, was so denominated because the notes, or musical characters, in that genus were written in colours. Others think that the word was figuratively employed, and expressed a greater variety of shade, more of contrast, than the other *genera*. Having no data to judge from, it is impossible to say which of the two opinions is the correct one; and, in truth, the question may just as well remain in its present state.

CHROMATIC THERMOMETER. [THERMOMETER.]

CHROME ALUM. [ALUMS.]

CHROME ORANGE. [LEAD, *Dichromate of.*]

CHROME YELLOW. [LEAD, *Chromate of.*]

CHROMIC ACID. [CHROMIUM.]

CHROMIUM (Cr) is one of the elements. It is a metal, but does not occur as such in nature, being always combined with oxygen. As sesquioxide it is found in a mineral called *chrome-ochre;* as chromate of lead, in *red-lead spar;* and as sesquioxide associated with protoxide of iron, in *chrome iron-stone.* The last-mentioned is the most important ore of chromium, but neither of them are very abundant. From the United States and from Norway there are annually imported into Great Britain about 1500 tons of chrome iron-stone; it is all consumed in the manufacture of colouring matters for the use of the painter, the dyer, and the calico-printer. To the latter fact the derivation of the word *chromium* is owing, from χρῶμα (*chroma*), colour.

Chromium was first discovered by Vauquelin, in 1797. (VAUQUELIN, BIOG. DIV.) He obtained it in a more or less fibrous or granular condition, by subjecting chromic acid, or sesquichloride of chromium, mixed with oil and charcoal in a well-luted crucible, to the heat of a

powerful furnace. More recently, M. Fremy has obtained the metal in crystals possessing great brilliancy. They belong to the cubic system, are very hard, and not acted upon by even the strongest acids. The crystals were formed on passing sodium vapour, by means of a stream of hydrogen, over the anhydrous chloride heated to redness.

By heating the sesquichloride of chromium with potassium, and washing the product with water, an allotropic modification of the metal is obtained. It presents the appearance of a dark gray powder, that under the burnisher assumes a metallic lustre. Heated in contact with air, it takes fire at a temperature below redness, and burns with considerable brilliancy, yielding sesquioxide. It is rapidly acted upon by acids, hydrochloric or dilute sulphuric dissolving it with evolution of hydrogen gas.

Chromium is of a light gray colour; its specific gravity is about 5·9. It is very brittle, non-volatile and non-magnetic. From the difficulty of preparing it in the metallic state, as well as on account of its comparative scarcity, this metal has not yet received any application in the arts.

Equivalent, 26·27.

Chromium and *oxygen* combine to form several compounds. The most important are four in number :—

	Formula.	Equivalent.
Protoxide of chromium . . .	CrO	34·3
Sesquioxide of chromium . . .	Cr_2O_3	76·5
Chromic acid	CrO_3	50·3
Perchromic acid	Cr_2O_7	108·5

To these may be added *chromoso-chromic oxide* (Cr_3O_4), corresponding to magnetic oxide of iron, and four other oxides, which may be viewed as combinations of sesquioxide of chromium with one, two, three, or four equivalents of chromic acid.

Protoxide of chromium (CrO) cannot be obtained in the anhydrous condition. The *hydrate* (CrO,HO) is precipitated when caustic potash is added to a solution of protochloride of chromium. Its colour is dark brown. It is a very unstable compound, rapidly absorbing oxygen, and becoming converted into a higher oxide. By careful manipulation it may be made to form salts with several of the acids. The double sulphate of protoxide of chromium and potash ($CrO, SO_3 + KO, SO_3 + 6Aq$) forms crystals of a fine blue colour.

Sesquioxide of chromium (Cr_2O_3). For use in enamel painting and glass staining : this is best prepared by heating chromate of mercury to redness; metallic mercury and oxygen are given off, and the sesquioxide remains as a deep green powder. It may also be obtained by heating bichromate of potash with carbonate of potash and chloride of ammonium, or with sulphur only, or with charcoal, or, finally, by heating bichromate of potash alone; in the latter case the following decomposition takes place :—

$$\underbrace{2\,(KO, 2\,CrO_3)}_{\text{Bichromate of Potash.}} = \underbrace{Cr_2O_3}_{\text{Sesquioxide of Chromium.}} + \underbrace{O_3}_{\text{Oxygen.}} + \underbrace{2\,(KO, CrO_3)}_{\text{Neutral Chromate of Potash.}}$$

The oxide thus prepared presents a beautifully crystalline appearance.

The *hydrated sesquioxide* of chromium ($Cr_2O_3, 9HO$) is a grayish-green precipitate; and when obtained by adding solution of ammonia to a cold solution of a violet-coloured salt of chromium, is then soluble in ammonia, acetic acid, or dilute solutions of potash; dissolved in strong acids violet-coloured solutions are obtained. Under other circumstances, however, hydrated sesquioxide of chromium possesses properties the very reverse of those just mentioned; its composition remains the same, but it is no longer soluble in ammonia, acetic acid, or dilute solutions of potash; a distinct isomeric condition is set up. Very slight causes are sufficient to effect this modification; thus the action of boiling water, desiccation in the open air, or even in vacuo after some time, or mere friction, are, according to M. Fremy, sufficient to determine this change from the soluble to the insoluble variety.

The *salts of the sesquioxide* of chromium, like the sesquioxide itself, exist under different isomeric modifications. Thus *sulphate of chromium* is obtained of a *violet* colour, when eight parts of hydrated oxide dried at 212° are digested with nine parts of concentrated sulphuric acid in a shallow vessel for two or three weeks; at the end of that time the mixture is usually converted into a mass of crystals having the composition ($Cr_2O_3, 3SO_3, 15HO$). With the sulphate of potash, this variety forms a beautiful violet-coloured double salt called *chrome alum*, from the fact that it is in all respects similar to common alum, except that it has chromium in the place of aluminium. [Alums.]

The *green sulphate* of chromium is formed when solution of the violet sulphate is boiled; it is uncrystallisable.

A *red anhydrous* sulphate ($Cr_2O_3, 3SO_3$) is obtained in crystals when either of the preceding sulphates are heated to about 700°. It is quite insoluble in water, or concentrated acids; long contact with water, however, converts it into the soluble variety.

The other salts of sesquioxide of chromium are comparatively unimportant; in general properties the sulphate is a type of them. M. Fremy distinguishes those of a violet colour as *salts of metachromic sesquioxide*, and those possessing a green tint as *salts of the ordinary oxide*. When the former are converted into the latter by ebullition no alteration in chemical composition takes place, the change is entirely due to the isomeric modification of the oxide contained in them as before adverted to.

Tartrate of chromium ($2Cr_2O_3, C_8H_4O_{10}$), obtained by digesting hydrated sesquioxide of chromium in solution of tartaric acid. The resulting liquid is deep green by reflected light, and violet by transmitted light.

Bitartrate of chromium ($Cr_2O_3, HO, C_8H_4O_{10}$), or rather—

Chromotartaric acid ($C_8H_5(Cr_2O_2)O_{12}$), that is, tartaric acid ($C_8H_6O_{12}$) in which an equivalent of hydrogen is replaced by (Cr_2O_2). Chromotartrate of potash is prepared by adding powdered tartaric acid to a hot aqueous solution of bichromate of potash till evolution of carbonic acid ceases; the re-action is somewhat complicated. By double decomposition with acetate of lead, a bluish green precipitate of chromotartrate of lead is produced, and from this by means of a current of sulphuretted hydrogen the chromotartaric acid is isolated.

Chromic acid (CrO_3) crystallises in beautiful crimson needles on the cooling of a mixture of about four parts of a saturated solution of bichromate of potash, and five parts of concentrated sulphuric acid; on pouring off the mother liquor and draining the crystals for some time on a porous tile, they are obtained nearly pure.

Chromic acid is anhydrous. On being heated it first blackens, at about 400° fuses to a bright reddish-brown liquid, and at a higher temperature is decomposed into oxygen and sesquioxide of chromium. Exposed to the air it rapidly deliquesces. It has a sour, somewhat rough taste, no odour, stains the skin yellow, and rapidly oxidises organic matter.

Chromates, formed by the union of chromic acid with bases, occur in three classes, basic, neutral, and acid; the *dichromate of lead* (*orange chrome*), containing two equivalents of oxide of lead to one of chromic acid ($2Pbo, CrO_3$) is a familiar instance of a basic chromate; *yellow chromate of lead* (*chrome yellow*) (Pbo, CrO_3) is a well known example of a neutral chromate; while *bichromate of potash* ($KO, 2CrO_3$) is a type of acid chromates. For details of the preparation and properties of the chromates, see the various metals, Lead, Mercury, Zinc, Potassium, &c.: also an excellent paper 'On the manufacture of chromate and bichromate of potash, chromate and bichromate of soda, chromate of lime, chromate and dichromate of lead, chromate of zinc, chromic acid, &c., &c.;' in the 'Pharmaceutical Journal,' vol. xv., pp. 32 and 66.

Bichromate of ammonia. A quantity of chromic acid is divided into two portions, the one neutralised with ammonia and the second portion then added. On evaporating the solution over strong sulphuric acid bichromate of ammonia crystallises, under the form of cherry red prisms; on exposing a few crystals of this salt, placed in a crucible capable of containing twenty or thirty times the quantity, to the flame of a lamp, a very energetic action ensues, accompanied with incandescence, and the crucible is filled with sesquioxide of chromium, in a form in which it presents a perfect resemblance to green tea.

The source of all the salts of chromic acid is of course *chrome iron ore*, which is oxidised either by a nitrate or more simply by atmospheric air.

Perchromic acid (Cr_2O_7) is formed whenever an aqueous solution of peroxide of hydrogen is brought into contact with chromic acid. The liquid assumes a deep blue colour, but is rapidly decomposed with evolution of oxygen; if, however, the solution be agitated with ether the acid is withdrawn from the aqueous portion, and may be made to unite with ammonia or certain organic bases to form tolerably stable compounds. Strong acids decompose the perchromates, and separate blue perchromic acid.

Chromium and *chlorine* combine to form a protochloride and a sesquichloride.

Protochloride of chromium (CrCl) is formed on passing a current of dry hydrogen gas over the sesquichloride, heated to redness; hydrochloric acid is given off, and the protochloride remains as a white powder. It is soluble in water, yielding a blueish green solution that rapidly absorbs oxygen from the air.

Sesquichloride of chromium (Cr_2Cl_3) is a very beautiful substance, having the form of transparent plates, in colour resembling, but somewhat darker than, peach blossoms. It is readily obtained on passing a current of dry chlorine gas over a mixture of sesquioxide of chromium and charcoal heated to redness in a porcelain tube; the sesquichloride, being volatile, sublimes and condenses in the cool extremity of the tube. It is scarcely altered by even long exposure to air, and if pure is quite insoluble in water or in acids; the presence, however, of a trace of protochloride renders it easily soluble. Solution of sesquichloride of chromium is most readily made by deoxidising a solution of bichromate of potash, containing excess of hydrochloric acid, with either alcohol or sulphite of soda; if required quite pure, the solution may be supersaturated with ammonia, and the precipitated oxide washed and dissolved in hydrochloric acid.

Chlorochromic acid always results when hydrochloric, sulphuric, and chromic acids are heated together; the presence of any water prevents the re-action. To prepare it in the pure state, 10 parts of chloride of sodium are fused with 17 parts of neutral chromate of potash; when cold, the mass is broken up, placed in a retort, and 30 parts of the strongest sulphuric acid added; on gently mixing the ingredients, sufficient heat is generated to volatilise the chlorochromic acid, which distils over, and may be condensed in a cooled receiver.

Chlorochromic acid is an intense red liquid. In the air it emits dense fumes, that have an odour more suffocating, if possible, than chlorine. Brought into contact with ammonia a re-action is set up, that usually is sufficiently energetic to inflame the mixture. Passed through a red-hot porcelain tube the vapour deposits brilliant rhombohedral crystals of sesquioxide of chromium. These crystals are of a dark green colour, and sufficiently hard to cut glass.

Chlorochromic acid (Cr_2ClO_2) may be regarded either as chromic acid (CrO_3) in which 1 equivalent of oxygen is replaced by an equivalent of chlorine, or as 2 equivalents of chromic acid united with 1 equivalent of terchloride of chromium, thus :—

$$3(CrClO_2) = (CrCl_3 + 2CrO_3)$$

Chromium combines with *iodine* and *bromine*, but the compounds formed have not been analysed. The *phosphide* and *sulphide* of chromium are not important bodies.

Terfluoride of chromium ($CrFl_3$) is a blood-red liquid, obtained by distilling a mixture of 4 parts of chromate of lead, 3 of powdered fluor spar, and 8 of concentrated sulphuric acid, in a platinum retort. It fumes very strongly in the air, giving off irritating vapours of chromic acid.

Cyanide of chromium (Cr_2Cy_3) is a blueish-gray precipitate produced on mixing solutions of sesquichloride of chromium and cyanide of potassium.

Chromohydrocyanic acid (Cr_2Cy_3,3HCy), or chromocyanide of hydrogen, is a body analogous to hydroferricyanic acid. The potassium salt (Cr_2Cy_3,3KCy), isomorphous with ferricyanide of potassium, is produced on exposing to the air a mixture of caustic potash, hydrated oxide of chromium, and hydrocyanic acid. From this salt other chromocyanides may be obtained by double decomposition. By the action of sulphuretted hydrogen on the silver salt, the acid itself is isolated.

Amido-chromic bases containing chromic oxide (Cr_2O_3) united with several atoms of ammonia (NH_3) have recently been obtained by M. Fremy. An interesting fact connected with these bases is, that the ammonia taken up entirely loses its power of saturating acids. Thus, *roseo-chrome* (Cr_2O_3,4NH_3), like the sesquioxide itself, combines with three equivalents of an acid to form neutral salts; the four equivalents of ammonia which enter into its molecule exercise, therefore, no influence upon its capacity of saturation. The *sulphate of roseo-chrome* ((Cr_2O_3,4NH_3),3SO_3) is obtained by acting with sulphuric acid on the violet granular body (*amide of chromium*), that deposits on exposing to the air a solution of metachromic sesquioxide in an ammoniacal salt containing excess of ammonia.

Tests for the salts of chromium. Sesquisalts give a green precipitate (of oxide) with sulphide of ammonium; no precipitate with sulphuretted hydrogen; with ammonia a bulky gelatinous precipitate (of hydrated sesquioxide); with the fixed alkalies a green precipitate, soluble in excess, and reprecipitated on boiling.

Soluble salts of chromic acid give a yellow precipitate (chromate of lead) with lead salts; a red precipitate (chromate of silver) with nitrate of silver; and an orange precipitate (subchromate) with subnitrate of mercury.

The quantitative estimation of chromium is most conveniently performed by obtaining it in the form of chloride, precipitating with ammonia and well washing, and igniting the resulting oxide in a covered platinum crucible; 100 parts contain 68·68 of chromium.

CHROMOHYDROCYANIC ACID. [CHROMIUM, *Cyanides of.*]

CHROMOTARTARIC ACID. [CHROMIUM, *Tartrates of.*]

CHROMULE. [CHLOROPHYLL.]

CHRONICLE, CHRO'NICON (*χρόνος*, time), denotes a history in which facts are digested in order of time, though not necessarily in successive years, as is distinctly implied in the word Annals. It must be owned, however, that the two terms have been indiscriminately used for histories in which the succession of years has been the governing principle of the narrative. The term chronicle, at the present day, is seldom used but in speaking of our old histories, as the 'Saxon Chronicle;' 'Caxton's Chronicle;' 'Fabyan's Chronicle;' 'Holinshed's Chronicle;' &c. This term was also adopted by the French, as in 'Froissart's Chronicles,' 'Monstrelet's Chronicles,' and in 'Les Chroniques de France (appellés la Chronique de St. Denys), compilés par l'ordre du Roy Charles VIII.' [ANNALS.]

CHRONICLES, the name of two books of the Old Testament. In the original Hebrew they constitute only one book, entitled דִּבְרֵי הַיָּמִים (Dibrē Hayyamim), *Verba Dierum*, Words of Days; that is, diaries or journals. In the Septuagint they are called *Παραλειπόμενα*, *res prætermissæ*, "things omitted." The Books of Chronicles have been so called from being considered as supplementary to the Books of Samual and of Kings; the histories of which they repeat with considerable variations. The name Chronicles seems to have been first applied by St. Hieronymus (Jerome). Much difference of opinion has been entertained as to the compilers; but the general tendency of all critical opinion, ancient and modern, ascribes the authorship to Ezra, after the return of the Jews from the seventy years' captivity in Babylon. Eichhorn enumerates several reasons for attributing them to Ezra ('Einleitung,' vol. ii.), one of which is a similarity to the books of Kings and Ezra in style, orthography, and idiom; but this assumes that Kings was written by Ezra, an opinion not now generally entertained.

The Jews also ascribe them to Ezra. Several objections have, however, been taken as to the probability of their being his work (Calmet's 'Dict.' by Taylor), one of which is, that (Chron. iii. 19, *et seq.*) an account is given of the posterity of his contemporary Zerubbabel, which extends to nine generations, or about 300 years, beyond the time of Ezra; but nothing, as Eichhorn observes, is certainly known of the time either of Ezra's birth or his death, and nothing is more likely than that a genealogy of the house of David, a matter of great interest to the Jews, should have been interpolated by a later hand. An objection has also been raised on account of certain discrepancies between the statements in the books of Chronicles and of Kings, on the supposition that if Ezra compiled Kings he would not have contradicted himself in Chronicles. But the most likely theory is that Kings was compiled by Jeremiah. Dr. A. Dillman (in Herzog's 'Real Encyklopädie,' 1853) contends that the Books of Chronicles must have been written about 330 B.C., but that they and Nehemiah also contain fragments of the older composition. The Rev. T. H. Horne ('Introduction to the Holy Scriptures') also decides against the authorship of Ezra.

The numerous contradictions throughout Chronicles and Kings, in facts, dates, numbers, names, and genealogies, are acknowledged by many learned critics. They form the subject matter of nearly the whole of Dr. Kennicott's 'First Dissertation on the State of the Hebrew Text;' where they are treated as corruptions, interpolations, and mistakes. In the narrative 1 Chron. xviii. 3, which is taken verbatim from 2 Sam. viii. 3, there occurs, besides a variation of proper names, an alteration of 700 horsemen to 7000: and exactly "the same mistake" (Kennicott) occurs in the passage cited in 1 Chron. xix. 18, from 2 Sam. x. 8. Compare also the numbers in 1 Kings iv. 26, with 2 Chron. ix. 25; and 1 Kings ix. 23, with 2 Chron. viii. 18; and the statement of Ahaziah's age in reference to that of his father, in Chron. xxi. Most, if not all these apparent inconsistencies, are, however, reconcileable, and this has been well done by Dahler and Keil, Eichhorn and Häverneck, in Germany, and by Dr. Kitto in the 'Pictorial Bible,' and Dr. S. Davidson in his 'Sacred Hermeneutics.' Spinoza, De Wette, and Gramberg have been the most strenuous opponents to the credibility of the books of Chronicles.

Many passages and chapters in Chronicles and Kings appear to have been transcribed verbatim from records made before the Babylonian captivity, while the Temple was standing: as 2 Chron. v. and 1 Kings viii., which are word for word alike, and speak of the ark, the former in v. 9, the latter in v. 8, as being in the Holy Place "unto this day;" though neither Kings nor Chronicles are supposed to have been written until from sixty to ninety years after the Temple, and all its contents had been demolished, or carried off by Nebuchadnezzar. Another instance is in 2 Chron. viii. 8. The last thirteen verses of 1 Chron. i., occur verbatim in Genesis xxxvi., and appear to have been transcribed from some historical document made after Saul, the first king, reigned in Israel (see v. 31), which was 400 years after the death of Moses. Another curious particular is that the two last verses of 2 Chron. concerning the proclamation of Cyrus, are the same which begin the following books of Ezra. This has been shown by Grotius to have been merely a mark of continuation in ancient books, and that it was so used by Procopius in his 'Hist. Vandalicorum et Gothicorum.' The broken sentence with which Chronicles end at "go up," is completed in v. 3 of Ezra "to Jerusalem," &c.

To this may be added a fact not noticed by the commentators, that the Jews, in the public reading of their scriptures, to avoid ending with the recital of any calamity producing dejection, add the commencement of the next paragraph, or repeat a portion of that which precedes, in order to finish with something consolatory. Accordingly, in Hebrew copies, at the end especially of Isaiah, Malachi, Lamentations, and Ecclesiastes, a masoretic sign is given, formed of the initials of these four books (יחזקק) to indicate the recital of some antecedent or subsequent passage. It is supposed by St. Hieronymus that the present books of Chronicles are those of the kings of Judah and of Israel, so often referred to in the books of Kings. The objection to this supposition is, that these references are not unfrequently made to what is not to be found in the present book of Chronicles. The Chronicles referred to in Kings are generally thought to have been a voluminous work from which ours are only a brief and mutilated abstract. Grotius, Capellus, Spinoza, Clericus, R. Simonius, Whiston, and others, hold this opinion. The chief design of this compilation seems to have been to exhibit, first, the genealogies, ranks, and functions of the priesthood, in order that, after returning from the captivity, they might re-assume their proper dignities; and secondly, by describing the distribution of lands before the captivity, to direct the families of each tribe in regaining their ancient inheritances. The first book is a recapitulation of sacred history from the creation to the death of David. The second book gives the history of the kings of Israel and Judah from Solomon to the return from Babylon. The authority of the books of Chronicles is established by St. Paul applying a prophetic passage (Heb. i. 5) to the character of our Saviour from 1 Chron. xvii. 13 and 14; see also chap xxii. 10. (Bishop Mant's 'Bible.') For the purpose of comparison and critical investigation, see the table of Chronicles, Samuel, and Kings, in Horne's 'Introduction to the Bible,' also Cruttwell's 'Concordance of Parallels.' The

books of Chronicles contain many striking and beautiful passages, such as David's prayer and thanksgiving for the people's offerings towards building the temple; Abijah's address to Jereboam; Asa's prayer before the battle against Zerah the Ethiopian; and many others.

CHRONOLOGY (from the Greek word *χρονολογία*), literally signifies "time-reckoning." In contradistinction to history, which connects events according to the manner in which each is produced or occasioned by another, chronology regards events simply according to the order of time. It is evident, however, that the succession of events in the order of time makes a very important part of their exposition in the relation of cause and effect; for whatever else there may be in the bond which unites what we call a cause and its effect, the circumstance that the cause precedes the effect in the order of time is always present. A history therefore cannot be written even in the loosest manner, nor an intelligible narrative put together, without chronology being so far attended to that the events shall be related in the order in which they happened. Even what is called the epic method of taking up the story in the thick of the interest rather than from the beginning of the series of events out of which the interest grows, is no exception. In whatever mode it may be thought best for the effect intended to be produced that the several portions of the story should be arranged and exhibited, each portion must in itself be detailed chronologically, else it will be incomprehensible. And even in an epic poem an order of time is always strictly observed throughout, though the poet may select a different series of events through which to take his course from that which would be adopted by the historian. In the Æneid, for example, it is true that the events of the shipwreck of Æneas and his followers, and their reception by Queen Dido, which are related in the first book of the poem, happened subsequently to the destruction of Troy, and their adventures in the course of their navigation to Carthage, which pass before the reader in the second and third books; but these last-mentioned events are really not what the poet professes to relate in these two books. What they profess to contain is the discourse addressed by Æneas to Dido, at the banquet in her palace; and the delivery of this discourse happened not before but after the events related in the first book of the poem.

The order of a history, however, will often differ from that of a purely chronological arrangement in this respect. In the former each connected series of events is related separately, and thus form a unity, in which the progress and development of certain principles, causes, or given conditions of society are exhibited. In the latter, events of various naturally distinct series are necessarily intermixed, nothing being attended to except the order of time in which they happened. Thus a mere chronological table, or chronicle, of the events of the last century would enumerate, under no arrangement except the order of time, the events which had taken place during that period in all the countries of the world, and in all the departments of human action, and also it might be of inanimate nature; if the scheme were comprehensive enough, the notice of an inundation of the ocean, or an eruption of Vesuvius, might break in upon the detail of a succession of scientific discoveries, or the incidents of a political revolution. History, in the pursuit of its proper business of tracing each effect to its cause, necessarily avoids this intermixture. It follows one chain of events, at least up to a certain point at which a pause may conveniently be made, and then it takes up another chain. Still each chain is continued in the chronological order of its links. Every long history, indeed, must in this way be properly a collection of many short histories; and these latter will be numerous in proportion to the extent and complexity of the subject. Neither a history nor a chronicle need embrace all the recorded or remarkable events of the period over which it professes to extend; the one as well as the other may be confined to events or transactions of any particular kind, as well as of any particular period. But whatever variety of matters may be comprehended in a history, it is at the option of the historian, and belongs to his art, to dispose them into as many distinct narratives, or portions of a narrative, as may appear best suited for their clear and effective exposition; whereas all the facts, however various, which a chronicle or chronological table may comprehend, must be related in one narrative or series. Though an intermixture of all kinds of events with those that more peculiarly belong to chronology, which are the events of political society, is not unusual in tables of chronology, the events of any one branch of human action or speculation, or, as already observed, the phenomena of nature, might often with more propriety be exhibited in separate chronological tables.

It has sometimes been attempted to combine in a chronological table, with its own peculiar advantages, something of this distinctness or separation of one subject from another which is found in a history, by employing a particular form of type or other appropriated mark for each series of connected events. This method was first employed, as far as we know, and indeed it is there claimed as new, in a short general chronological table at the end of the work entitled 'Elements of General History,' by Alexander Fraser Tytler (afterwards Lord Woodhouselee), 2 vols., 8vo., Edinburgh, 1801. In this table the series of the kings and emperors of Rome is printed in a larger Roman type than the rest of the table, that of the emperors of Germany in Italic capitals, that of the kings of England in the old English letter, that of the kings of France in small Italics, &c. "By this method," to quote the explanation of the compiler, "the succession of the sovereigns in

the different kingdoms is immediately distinguishable to the eye, as well as the duration of their reigns, while the intervening space is filled by the remarkable events that occurred at that period all over the world; and thus the connection of general history is preserved unbroken."

Some histories are written in a more, some in a less strict chronological order. It is observed by Dionysius of Halicarnassus, in a comparison between Herodotus and Thucydides, that Thucydides has followed the order of time, Herodotus that of things, and that on this account Thucydides is obscure and difficult to understand. While Thucydides, he says, has divided his single subject into many parts, Herodotus, having in his history embraced many different subjects, has formed them into a single whole, of which the several parts perfectly correspond. But though the method of Herodotus may be the best adapted for conveying a clear view of each particular portion of history of which he has treated, every series of naturally connected events forming a narrative or story by itself, it is not easy to gather from his work any notion of the synchronism of events, or of the relation of those of one series to those of another in point of time. Larcher, in the preface to his French translation of Herodotus (edition of 1802), has noticed that Photius has complained of the confusion occasioned by the digressions of this author, and that other critics have been disposed to deny that he followed any regular or intelligible plan. Larcher, however, dissents from this judgment, and explains what he conceives to have been the plan of Herodotus ('Preface,' pp. xxv.–xxxii.) He has also printed, with annotations, in his sixth volume, three memoirs by the Abbé Geinoz, in vindication of Herodotus against the attacks of Plutarch; and of these the third (pp. 601–627) is an exposition of the method and plan of the historian. His history is of the form of an epic poem, of which the main subject is the wars of the Greeks and Persians. The digressions, which correspond to the episodes of an epic poem, and, as in the case of that on Egypt, take up an entire book, render it very difficult for a young student to form an idea of the history as a whole. But if the episodes are cut out, the whole history exhibits the main subject in a regular progress and order. The chronological system of Herodotus has been amply illustrated by Larcher, in his 'Essai de Chronologie sur Hérodote,' printed in the sixth volume of his first edition (1786), and, greatly altered and enlarged, in the seventh volume of his second edition.

But although both Herodotus and Thucydides have, each after his own method, so far adhered to a chronological arrangement as to relate the events in the order of time in which they happened, neither of these writers has throughout his narrative attended to chronology in any scientific sense. They were both prevented from doing this by the want, in that early age, of any fixed epoch or starting-point from which to reckon. It has been well observed, that "the best simile for dates is to say, that they are to history what the latitude and longitude are to navigation—fixing the exact position of, and serving as unerring guides to, the object to which they are applied." (Nicolas's 'Chronology of History,' preface, p. vi.) In this view the histories of Herodotus and Thucydides may be compared to charts or maps drawn without the aid of parallels of latitude or meridian lines, in which indeed, the situations of cities and mountains, the courses of rivers, and the general form of countries and outline of coasts, might be represented with a certain degree of correctness, but not with the precision requisite for any scientific purpose. Thucydides, however, in recording the events of the Peloponnesian war, keeps to the order of the years; and he fixes the date of the commencement of the war (ii. 2), by referring to the truce made after the capture of Eubœa, to the priesthood of Chrysis in Argos, to the ephorship of Ainesias at Sparta, and the archonship of Pythodorus at Athens. In speaking of events that happened long before the war (i. 13, 19), he refers to the end of the Peloponnesian war as the point from which to reckon backwards.

The determination of the length of the year and the regulation of the calendar appear to have occupied the attention of the ancients, before they ever thought of dating events from a fixed epoch. But the latter object was of interest only to historical inquirers; the former matters were naturally in the hands of the cultivators of astronomy, who were the best qualified for their management, and were besides more immediately interesting and important to the whole community. There is a curious passage in the 'Clouds' of Aristophanes, in which the clouds, addressing the people of Athens, report a complaint made by the moon, about the displeasure she had incurred from the gods in consequence of the confusion into which their festival days had fallen; the allusion, it has been supposed, being to Meton's reformation of the calendar, which had recently been introduced. ('Clouds,' 603, &c.) Aristophanes was a contemporary of Thucydides.

The first æra, or computation of time from an epoch, made use of among the Greeks was that of the Olympiads. "Hail, venerable Olympiads, ye guardians of time, ye vindicators of the truth of history, ye bridlers in of the fanatical licence of chronologists!" exclaims Joseph Scaliger, in his 'Animadversions on Eusebius,' in a paroxysm of chronological enthusiasm. The date of the original institution of the Olympic games is placed in very remote antiquity; but it was a long time even after their revival by king Iphitus (B.C. 884) before they came to be used for the purpose of fixing historical events. The following paragraph is from the introduction to Playfair's 'Chronology,'

with the exception of the dates within brackets: "Hellanicus [B.C. 496–411] regulated his narration by the succession of the priestesses of Juno at Argos. Ephorus [B.C. 300] digested things by generations. The Arundelian marbles [B.C. 263] make no mention of olympiads, and reckon backwards from the time then present by years. In the histories of Herodotus [B.C. 484–413] and Thucydides [B.C. 471–391] the dates of events are not ascertained by any fixed epochs. The olympiads were not commonly applied to this purpose in so early a period. Timæus of Sicily, who flourished in the reign of Ptolemy Philadelphus [B.C. 283–245], was the first who attempted to establish an æra, by comparing and correcting the dates of the olympiads, the Spartan kings, the archons of Athens, and the priestesses of Juno. Eratosthenes [B.C. 194], the father of chronology, and Apollodorus [B.C. 115] digested the events recorded by them, according to the olympiads and the succession of Spartan kings." When the olympiads were adopted as an æra, the reckoning was made to commence from the games at which Corœbus was the victor, being the first at which the name of the victor was recorded. The olympiad of Corœbus accordingly is considered in chronology as the first olympiad. Its date is placed 108 years after the restoration of the games by Iphitus, and is calculated to correspond with the year B.C. 776.

The statement we have just quoted from Playfair is given at greater length, and with references to the authorities, in the first chapter of Sir Isaac Newton's 'Chronology.' Of the names that have been mentioned, only Eratosthenes and Apollodorus can be considered as having been systematising chronologers, or as having employed themselves on the science of chronology. The merits of Timæus appear to have consisted in his endeavouring to ascertain with greater precision than any preceding historian the dates of the events of which he treated in his histories of Sicily, of the wars of Pyrrhus, &c. An account of his works is given in Clinton's 'Fasti Hellenici,' iii. 489–491. The fragments of Timæus have been collected by Goeller, in his work, 'De Situ et Origine Syracusanorum,' 8vo, Leipzig, 1818. Eratosthenes, the eminent astronomer, seems to have endeavoured to establish what may be called a system of chronology by ascertaining the dates of certain ancient events, which might serve as fixed points from which to reckon all other events. We have no account however of the process by which he arrived at his conclusions. The fragments of his chronological as well as of his other writings, with the passages of the ancient authors in which each is mentioned, and notes, have been published by Gottfr. Bernhardy in a small volume, entitled 'Eratosthenica,' 8vo., Berolini, 1822. The dates which he affixed to the principal events of antiquity are given from Clemens Alexandrinus, in Clinton, i. 124. Those of Apollodorus, who made some corrections on the system of Eratosthenes, are given in Clinton, i. 125, as preserved by Eusebius on the authority of Porphyry. Clinton has shown that the leading dates of Eratosthenes and Apollodorus were adopted generally by subsequent chronologers, both Greek and Latin. Among the Romans the most eminent authority in chronology was Varro, who flourished in the century immediately preceding our æra, but of whose nnmerous and learned works very little remains. Belonging to a much later age, the 3rd century of our æra, there has been preserved the work of Censorinus, entitled 'De Die Natali,' which is in the greater part a treatise on dates, epochs, and other matters appertaining to the science of chronology. There is a passage in the twenty-first chapter of Censorinus, containing a memorandum of the distance of the year in which he wrote (A.D. 238) from the first olympiad, from the building of Rome, from the reformation of the calendar by Julius Cæsar, and from other epochs, which has been thought so important to chronology, that Petau has attributed its preservation to the special goodness of Providence.

The establishment of the first olympiad as a common epoch may be said to have given birth to chronology as a science, by introducing into historical writing the general practice of dating events with reference either to that or to some other fixed point. The principal business of chronologers after this was to determine the relationship of each of these epochs to every other.

The common æra of the Roman historians commences from the foundation of the city of Rome. But there was a great variety of opinion among the ancients, as there has continued to be among the moderns, respecting the true date of this event. The Romans themselves for the most part followed either the computation of Cato, which places it in B.C. 752, or that of Varro, which assigns it to B.C. 753. Some writers, among others Livy, appear to reckon sometimes by the one, sometimes by the other; most modern chronologers follow that of Varro. This practice of dating events from the building of Rome may be regarded as the first adoption of the simple method of reckoning from a fixed point by single years, and as forming therefore one of the great stages of chronology.

Another usual mode of reckoning among the Latin historians was by the annual consulships. Often both the year of the city and the names of the consuls are given.

The method of reckoning from the first olympiad was occasionally employed long after the birth of Christ. "Some writers," says Playfair, "have continued the use of the olympiads to the 312th year of the Christain era. Cedrenus (a Greek monk of the 11th century) has brought them 80 years lower, making the 393rd year of our Lord the last olympian year." Sir Harris Nicolas ('Chronology of History,' p. 2) speaks of the computation by olympiads having ceased after the

364th olympiad, in the year of Christ 440. Particular writers may have reckoned by olympiads down to that date, as they might down to the present day; but it had certainly long before ceased to be the common practice to do so. From A.D. 312 the regular public mode of computation throughout the Roman empire, both west and east, was by the indictions, which were cycles or periods of fifteen years, beginning with that year. [INDICTION.] The practice of dating events by indictions was at one time followed in most of the kingdoms of modern Europe, and in France was not altogether discontinued till the end of the 15th century. The method of dating events from the birth of Christ is said to have been first practised by a Roman monk named Dionysius the Little about the year 527. It came into general use in Italy before the termination of that century, but in France not until the 8th century, in Spain not until the 14th, and in Portugal not till after the commencement of the 15th. The method of reckoning from this epoch, being now universally adopted throughout Christendom, and being the only computation generally used both in historical accounts of past events and in dating current time, has furnished a chronological measure of much more extensive application than any other which had preceded it. It is generally held that the birth of Christ actually took place about four years earlier than the date assigned to the event by Dionysius; but this mistake of the inventor of the vulgar æra does not affect its value as a scheme of chronological notation. It is quite unimportant which the point is from which we reckon, if it be a determinate point.

There is one inconvenience however attending the choice of an event for reckoning from so recent as the birth of Christ, namely, that it necessarily introduces two modes of reckoning, and leaves the events of a large, in fact of the largest, portion of history to be as it were dated backwards, or according to the distance of each behind the assumed epoch. Even the era of the olympiads was not free from this objection; for although, as we learn from Censorinus, Varro considered the historical age to commence only with the first olympiad, the traditions even of the Greeks ascended to fully four hundred years beyond that date. The histories and traditions of the Hebrews, and other ancient nations, extend much farther back. To provide a more comprehensive mode of reckoning, Joseph Scaliger, in 1582, invented what he called (after Julius Cæsar) the Julian period, being a cycle of 7980 years, which was made to begin at the year 4713 B.C. [PERIODS OF REVOLUTION.] A period still more remote of 15,969 years was invented by Jean Louis d'Amiens, and named the Louisian, in honour of Louis XIV., but this has been very seldom used.

If the date of the creation of the world, or rather of man's appearance on the earth, could be certainly established, that would form the natural and most convenient point from which to commence the reckoning of time and to date the events of human history. None of the ancient chronologers attempted to fix this point; a common opinion then held was, that the world was eternal: some conceived that any attempt to discover the commencement of its existence would be an act of impiety. Even among the Jews and Christians, whose sacred writings begin their record of events from the creation, there has been the greatest diversity of opinion as to that epoch. Kennedy in his 'Scripture Chronology,' affirms that 300 different opinions might be collected as to the length of time that elapsed between the creation and the incarnation. John Alb. Fabricius, in his 'Bibliotheca Antiquaria,' has given a list of 140 of these determinations. Dr. Hales, in his 'New Analysis of Chronology,' has collected above 120. In 'L'Art de vérifier les Dates.' vol. i., p. 27, &c., is given a list of 108. Playfair has given one of 88. Desvignoles, in the preface to his 'Chronology of Sacred History,' asserts that he has collected above 200 such calculations, of which the longest makes the distance between the two points to have been 6984, and the shortest only 3483 years.

The uncertainty and controversy upon this subject have been principally occasioned by the disagreement in the ages assigned to the Patriarchs, and in other numbers, between the Hebrew text of the Old Testament and the texts of the Samaritan and Septuagint versions. From the creation to the deluge the computation of the Hebrew text makes 1656 years to have elapsed; the Samaritan version only 1307; and the Septuagint 2262. The common opinion of modern theologians, and also of chronologers, has been that the Hebrew text is correct; and it is upon this assumption that Archbishop Usher, whose reckoning has been most generally adopted, has fixed the distance between the creation and the birth of Christ at 4004 years. But those who hold a contrary opinion, although the least numerous, have, according to Bayle, been usually *des savans d'élite*, inquirers of a superior order. It is maintained by Father Pezron, in his work 'De l'Antiquité des Tems,' that the Hebrew text was designedly corrupted by the Jews in the first century, and the time that had elapsed from the creation made to appear shorter than it really was, in order to meet the argument derived from what is said to have been an old Jewish tradition, that the coming of the Messiah should take place when the world was 6000 years old. Rabbi Akiba is supposed by Pezron to have been the author of the falsifications. Pezron makes the world to have been 5872 years old at the birth of Christ. The supposition of the corruption of the Hebrew text, and the preference due to the Greek translation of the LXX., has been adopted and supported by Dr. Hales, who will scarcely however be reckoned one of the *savans d'élite*.

Among modern systems of chronology, one of the most remarkable and peculiar is that proposed by Sir Isaac Newton, in his posthumous work, 'the Chronology of Ancient Kingdoms Amended,' 4to, London, 1728. Newton, assuming the nearly entire valuelessness of the determinations of the dates of ancient events by the Greek chronologers and their followers, proceeds to form a new system on considerations wholly independent of their authority. In the first place he has endeavoured to show that the ancient historians, when "a little after the death of Alexander the Great, they began to set down the generations, reigns, and successions, in numbers of years, by putting reigns and successions equipollent to generations, and three generations to 100 or 120 years (as appears by their chronology), have made the antiquities of Greece 300 or 400 years older than the truth." He contends that the reigns of kings, on an average, do not exceed eighteen or twenty years. Secondly, he has endeavoured to ascertain the date of the famous Argonautic expedition by an ingenious calculation founded upon the known precession of the equinoxes at the rate of a degree in seventy-two years (properly a degree is about 71½ years), and the assumption of the equinoxial and solstitial colures having at the time of the expedition cut the ecliptic in the cardinal points. From these data he determines the expedition to have taken place about the year 928 B.C., which gives an antiquity less by about three centuries than that commonly assigned to the event. But the grounds on which Newton had assumed the position of the colures at the time of the expedition are now generally acknowledged to be quite insufficient. Although the full exposition of this system was not published till after the death of the author, its general principles got abroad during his lifetime, and were attacked from various quarters. The two chief early assailants of the Newtonian chronology were the learned French Jesuit Souciet, and Nicolas Freret, known for his many valuable contributions to the memoirs of the Academy of Inscriptions. In latter times the system has been examined by Playfair (pp. 35–37), and by Hales (vol. i., pp. 26–29). See also Sir David Brewster's 'Life of Newton,' and a valuable note by M. Daunon to the article on Newton by Biot in the 'Biographie Universelle,' vol. xxxi., pp. 180–186. Clinton denies that the general uncertainty of the early Greek chronology is so great as is supposed by the scheme of Newton.

Although Newton's deduction of the date of the Argonautic expedition from the precession of the equinoxes cannot be depended on, owing to the want of any authority for the position of the colures at the time of the expedition, the science of astronomy has in another way rendered valuable assistance to that of chronology. This it has done by the means which it affords of ascertaining the exact date of many eclipses of the sun and moon which are recorded by ancient writers, and are sometimes connected by them with historical events that happened at or near the same time. In the first volume of the great French work, 'L'Art de Vérifier les Dates' (pp. 146–265), are given lists of all the eclipses of the sun and moon which could have been seen to the north of the equator for ten centuries preceding the birth of Christ; and secondly, of all those recorded before that epoch by ancient writers. In a subsequent volume of the same work there is inserted a list of the visible eclipses that have happened since the commencement of the vulgar æra. Lists of eclipses, solar and lunar, are also given in Playfair's 'Chronology,' pp. 175–219. As an example of the astronomical examination of a recorded ancient eclipse, see the article ALYATTES, in BIOG. DIV.

One of the earliest of the Christian systematic chronologers is Sextus Julius Africanus, who appears to have flourished in the first half of the 3rd century. Of his chronological work, entitled 'Pentabiblos,' however, beginning with the creation, which he dated B.C. 5499, and ending with A.D. 221, only some fragments remain. [AFRICANUS, BIOG. DIV.] The most important of the works of the early Christian chronologers which we now possess is the Chronicon of Eusebius Pamphili, bishop of Cæsarea, in the 4th century, of which an edition was published with notes by Joseph Scaliger in 1658, in one volume folio, containing the Latin translation by St. Jerome, and Scaliger's attempted restoration of the lost Greek text. The Armenian version of the Chronicon of Eusebius, which is more complete than the previous editions, was published at Venice in 1818, with a literal Latin translation, and another Latin translation of it, in the same year, at Milan. There is a famous Spanish commentary upon the Chronicle of Eusebius, by Alfonso Tostato, printed at Salamanca, in 5 vols. fol., in 1506. The work which is to be considered as having laid the foundation of the modern science of chronology is that of Joseph Scaliger, 'De Emendatione Temporum,' first published in folio at Paris in 1583, and afterwards, much augmented and amended, at Leyden in 1598, and at Geneva in 1629. Another important work of that age is that of Dionysius Petavius, or Petau, 'De Doctrinâ Temporum,' 2 vols. fol., Paris, 1627, with the Continuation in 1 vol. fol., Paris, 1630, entitled 'Uranologion, sive Systema variorum auctorum qui de Sphæra ac Sideribus, &c., commentati sunt.' An abridgment of this work, under the title of 'Rationarium Temporum,' was published at Paris in 8vo, in 1630, and has been several times reprinted. Of other early Continental works on chronology, the following are some of the most valuable, or the most celebrated:—Sethi Calvisii, 'Opus Chronologicum,' Leips. 1603, often reprinted; J. Bapt. Riccioli, 'Chronologia Reformata,' 2 vols. fol., Bonon. 1669; 'L'Antiquité des Tems rétablie et défendue,' par le Père Paul Pezron, Paris, 4to, 1687, and the Defence of that work by the author, Paris, 4to, 1691; Hier. Wecchietti Florentini, 'Opus de Anno Primitivo ab exordio Mundi ad Annum Julianum accommodato,' fol., August. Vindel., 1621, a work for which the learned and unfortunate author was shut up during the remainder of his life in the prisons of the Inquisition, his crime being his maintenance of the opinion that Christ did not celebrate the passover the last year of his life, and, in instituting the Eucharist, did not made use of unleavened bread; Philippi Labbe et Philippi Brietii, 'Chronologia Historica,' 5 vols. fol., Paris, 1670; 'Chronologie de l'Histoire Sainte,' par Alphonse Desvignoles, 2 vols. 4to, Berlin, 1738. The work of the Benedictine monks, Maur d'Antine, Durand, and Clemencé, first published in 1 vol. 4to, at Paris, 1750, and which, in the latest edition, extending to 38 vols. 8vo, published at Paris, 1818–31, under the title of 'L'Art de Vérifier les Dates, ou la suite Chronologique des événemens remarquables depuis la création du monde jusqu'en 1828,' has become the most extensive and important work on general chronology that exists. The principal works by English authors upon this science are the 'Chronicus Canon Ægyptiacus, Ebraicus, et Græcus,' of Sir John Marsham, fol., London, 1672, and also Leipzig, 1676, and Francfort, 1696; Archbishop Usher's 'Annales Utriusque Testamenti,' fol., Lond. 1650, and several times reprinted; Sir Isaac Newton's work, already noticed; Jackson's 'Chronological Antiquities,' 3 vols. 4to, 1752; Blair's 'Chronology and History of the World, from the Creation,' fol., 1754; again, 1768, with additions; and in 1857, in post 8vo, with very large additions, brought down to the date of publication,—a very useful work, but one that admits of some improvements in the arrangement, the dates of events occurring in any one year being too much scattered; Kennedy's 'Complete System of Astronomical Chronology, unfolding the Scriptures,' 4to, 1762; Playfair's 'System of Chronology,' fol., Edin. 1784; and the Rev. Dr. William Hales's 'New Analysis of Chronology, in which an attempt is made to explain the History and Antiquities of the Primitive Nations of the World, and the Prophecies relating to them,' 3 vols. 4to, 1800–1812. There is also a useful introduction to chronology by Bishop Beveridge, entitled 'Institutionum Chronologicarum Libri Duo, una cum totidem Arithmetices Chronologicæ Libellis,' 8vo, Lond. 1669, and several times reprinted. There are many good works on chronology in foreign languages, among which may be specially mentioned Ideler's 'Handbuch der mathematischen und technischen Chronologie,' Berlin, 1825-26. Particular portions of ancient chronology have been ably illustrated by Corsini in his 'Fasti Attici, in quibus Archontum Atheniensium series, Philosophorum, aliorumque illustrium virorum ætas, atque præcipua Atticæ Historiæ capita, describuntur,' 4 vols. 4to, Flor. 1744–61; by Wesseling, in his edition of Diodorus Siculus, 2 vols. fol., Amster. 1745; by Dodwell, in his 'Annales Thucydidei et Xenophontei,' 4to, Oxford, 1702; and by Larcher, in his 'Essai de Chronologie sur Hérodote,' already mentioned. But in so far as the Greek chronology is concerned, the most comprehensive, elaborate, and valuable work that has appeared is that of Mr. H. F. Clinton, entitled 'Fasti Hellenici: the Civil and Literary Chronology of Greece, from the earliest accounts to the death of Augustus,' in 3 vols. 4to, of which the first, comprising the chronology from the earliest accounts to the time of Pisistratus, was published at Oxford in 1834; the second, comprising the period from Pisistratus to Ptolemy Philadelphus, in 1824; and the third, completing the review to the end of the reign of Augustus, in 1830.

The volumes of chronological tables that have appeared are too many to be enumerated. Several of the systematic works on chronology that have been mentioned contain collections of such tables. The only other work which we shall mention is a most useful and, as far as we have examined it, very accurate publication, in one small volume, by Sir Harris Nicolas, entitled 'The Chronology of History,' which originally formed one of the volumes of Dr. Lardner's 'Cabinet Cyclopædia.'

[See the articles ÆRA, EPACT, EPOCH, CYCLE, DAY, MONTH, YEAR, INDICTION, &c.]

CHRONOMETER. [HOROLOGY.]

CHRONOMETER, in music, an instrument by which the movement, or time (that is, the quickness or slowness) of a composition is determined.

The musical chronometer is by no means a modern contrivance. So far back as the year 1636 Mersenne described and recommended it, in his 'Harmonie Universelle'; and Malcolm, a sensible writer, urged its use more than a century ago. Yet, owing to the prejudices of musicians, it has till lately not been employed, although its utility has been generally admitted. Dr. Crotch, an enlightened professor, advocated the use of a pendulum. The opponents of a *time-measurer* presume that it is meant rigorously to govern the *whole* of a composition, and that thus the beautiful effects of acceleration and retardation are to be sacrificed; but those who have advised the employment of a pendulum never contemplated its being used for any other purpose than to indicate the time to be adopted at the *commencement* of a movement. From the want or neglect of some contrivance by which the intention of composers might have been transmitted, we are now obliged to guess the true movements of the most classical works; and it is notorious that many compositions of the highest excellence, and among them several of recent date, are frequently performed in times which could not have been intended, because by good critics admitted to be exceedingly prejudicial to their effect. The invention, by the ingenious M. Maelzel, of a most accurate and convenient machine which he calls a Metronome, is beginning to convince musicians of the

utility of a pendulum; and we are persuaded that not many years will elapse before it will be universally adopted, both by composers and performers. That an advance has been made in its use is evident from the fact, that some composers and editors at the commencement of their printed pieces, now mark the time as indicated by the METRONOME.

CHRYODINE. A dark violet-coloured matter, produced by the action of sulphuric acid upon chrysammic acid.

CHRYSAMIDE. [CHRYSAMMIC ACID.]

CHRYSAMIDIC ACID. [CHRYSAMMIC ACID.]

CHRYSAMMIC ACID ($C_{14}H_2(NO_4)_2O_4$), is the product of the action of nitric acid upon extract of aloes. One part of the extract is heated in a capacious retort with eight parts of nitric acid of sp. gr. 1·37, and the mixture distilled till two-thirds of the nitric acid has passed over; an additional three or four parts of nitric acid is now added, and the whole kept at a temperature a little below the boiling point till no more gas is evolved. The re-action is complete in about three or four days, and on diluting the resulting liquid with water, chrysammic acid is precipitated, which, after washing with a little water, should present the appearance of a sparkling grayish-yellow powder; probably, however, it will be contaminated with a little aloetic acid [ALOETIC ACID], on account of insufficient oxidation. In that case it must be treated with a cold solution of carbonate of potash; the very soluble aloetate of potash separated by filtration and washing from the slightly soluble chrysammate of potash, and the latter dissolved in boiling water, and the chrysammic acid precipitated by nitric acid.

Thus obtained, the chrysammic acid is quite pure. It has the form of golden-yellow lustrous plates, is very slightly soluble in cold water, but a little more so in boiling water, yielding a solution of a purple-red tint, and a bitter taste. It is also soluble in alcohol, ether, and strong acids. Heated chrysammic acid decomposes with violent explosion, producing nitrous vapours and an odour resembling oil of bitter almonds.

The *chrysammates* containing an equivalent of a metal in the place of an equivalent of hydrogen in the chrysammic acid, are remarkable for their slight solubility. The crystalline salts have a greenish gold colour, and the insoluble amorphous salts take the same tint on rubbing with a hard body.

Chrysammate of potash ($C_{14}HK(NO_4)_2O_4$) crystallises in the form of flat rhomboidal plates, that possess an interesting polarising action upon light transmitted through them.

Chrysatic acid (Schunk's *aloeresinic acid*) is the name given by Mulder to an acid obtained on boiling chrysammic acid with caustic potash, and precipitating with an acid. It has a deep brown colour, and forms salts with most of the bases.

Chryiodine is the product of the action of concentrated boiling sulphuric acid on chrysammic acid. Its colour is intense violet. It has not been particularly examined.

Chrysamide ($C_{14}H_3(NO_4)_2NO_2$), obtained on boiling chrysammic acid with solution of ammonia:

$$\underbrace{C_{14}H_2(NO_4)_2O_4}_{\text{Chrysammic acid.}} + \underbrace{NH_3}_{\text{Ammonia.}} - 2HO = \underbrace{C_{14}H_3(NO_4)_2NO_2}_{\text{Chrysamide.}}$$

The solution, on cooling, deposits the substance in acicular crystals, reddish-brown by transmitted light, and having a green metallic lustre by reflected light.

Chrysamidic acid ($C_{14}H_5(NO_4)_2NO_4$) is formed when chrysammic acid is boiled with dilute hydrochloric or sulphuric acids,

$$\underbrace{C_{14}H_2(NO_4)_2O_4}_{\text{Chrysammic acid.}} + \underbrace{NH_3}_{\text{Ammonia.}} = \underbrace{C_{14}H_5(NO_4)_2NO_4}_{\text{Chrysamidic acid.}}$$

It crystallises, on the cooling of the solution, in needles that, when dry, have a deep olive-green colour. It forms salts with bases that resemble the chrysammates, but which may be distinguished from them by yielding ammonia when gently warmed with solution of potash.

Hydrochrysamide ($C_{14}H_6(NO_4)NO_2$) results on boiling chrysammic acid with solution of sulphide of potassium containing excess of caustic potash. It crystallises on cooling under the form of beautifully-coloured needles.

CHRYSANILIC ACID. [INDIGO.]

CHRYSANISIC ACID. ($C_{14}H_5(NO_4)_3O_2$.) An acid obtained by boiling nitranisic acid with fuming nitric acid. It crystallises in small scales of a magnificent gold colour. It is insoluble in water, but soluble in hot alcohol and ether. It is a monobasic acid, and forms an extensive series of salts termed *chrysanisalts*. It may be regarded as picric acid, in which one equivalent of hydrogen has been replaced by the compound radical methyl, thus:—

Picric acid	$C_{12}H_3(NO_4)_3O_2$
Chrysanisic acid.	$C_{12}H_2(C_2H_3)(NO_4)_3O_2$.

CHRYSA'NTHEMUM, a name applied to a genus of composite flowers, most of which are wild in different parts of Europe, and of little general interest; it is however popularly known from its also comprehending the *Chrysanthemum Sinense*, a Chinese half-shrubby plant, whose numerous varieties constitute one of the chief ornaments of gardens in the months of October, November, and December.

The native state of this species is not certainly known, all the many varieties now in gardens having been bought in the markets of Macao, from the Chinese traders. [CHRYSANTHEMUM, NAT. HIST. DIV.] In the cultivated state the plant has bluish-green broad leaves with sharp serratures and deep lacerations; and the flower-heads consist exclusively of ligulate florets of almost every colour, except blue. Pure white, bright yellow, deep and pale red, rich purple, and a dark morone brown, occur in different varieties of this favourite flower, and together contribute to the beauty for which the species is so much admired. It is probable that the numerous varieties cultivated by the Chinese, and now introduced to Europe, have been the result of ages of careful improvement, and that their properties have been derived partly from mere sporting and partly from intermixture with allied species unknown in Europe; for among those now cultivated are varieties remarkably different in constitution, many being capable of bringing their beautiful flowers to perfection in the open air, and thriving well even in the confined spaces and corrupted air of large towns, while others hardly unfold them even beneath the atmosphere of a green-house or stove. They all strike root with great facility by cuttings, which should be taken from the parent plant at midsummer, and planted in a cool frame under a bell-glass. After rooting they may be successively transferred from one sized pot to another, until they have formed two or three stout stems ready for flowering, when they must be finally left at rest. If the soil in which they grow is rich, and the air cool and moderately moist, with a free exposure to light, cuttings struck at midsummer will flower beautifully in the succeeding autumn. The size and perfection of their flowers is increased by about half of the flowerheads that naturally appear being destroyed. As the varieties of this plant are very numerous, and very different in their degrees of hardiness and beauty, it will be necessary for the grower to ascertain the nature of the varieties he is about to cultivate.

The varieties of the hardy class may be cultivated without any protection by having their stems pegged down upon the surface of the earth, so as not to be allowed to rise more than a few inches above it when in flower. So treated they form a charming ornament of a flower-garden; but the other kinds do not like this treatment.

Seeds of these plants have been obtained at Oxford and in Jersey, and many new varieties have been raised, among which are some that rival the handsomest of the Chinese sorts.

CHRYSATIC ACID. [CHRYSAMMIC ACID.]

CHRYSEN ($C_{12}H_4$) is one of the numerous compounds formed in coal tar. It is a yellow crystalline solid, melting at a temperature of 455°.

CHRYSOLEPIC ACID. [CARBAZOTIC ACID.]

CHRYSOPHANIC ACID. ($C_{20}H_8O_6$?) *Rhubarbaric Acid, Rhubarbarin, Rhein, Rheic Acid, Rheumin, Rhaponticin, Rumicin,* is found in the *Parmelia parietina*. It occurs in the form of golden yellow crystals, and with solutions of potash and ammonia, in alcohol, yields a beautiful red colour.

CHRYSORHAMNIN ($C_{28}H_{11}O_{11}$), the yellow colouring matter of Persian berries—the fruit of the *Rhamnus amygdalinus*. It crystallises in beautiful golden yellow stellar groups. By solution in water or in alcohol it is decomposed, and converted in *xanthorhamnin* ($C_{28}H_{12}O_{14}$). It is soluble in ether without decomposition, and is deposited again on evaporation of the solution.

CHURCH, or KIRK, which is precisely the same word in a varied orthography, is supposed to be the Greek word *κυριακός* (kuriakos), a derivative of *κύριος* (lord), one of the designations of Jesus Christ, the founder of the Christian system. It is one of the Saxon adoptions from the Greek. *Κυριακος* is an adjective, and we must understand after it some word denoting flock, or house, the Lord's flock, the Lord's house; the two senses in which kirk, or church, is used.

Of church, as denoting an edifice appropriated to Christian purposes, we treat in a separate article. We have now to speak of it as a term used to designate bodies or communities of men, when contemplated under the aspect of being persons who are followers of the Lord Jesus Christ. We shall endeavour to exhibit and illustrate the various senses in which it is used with as much completeness as our limits will allow. The word church has been used from the most remote period to represent the Greek term *ἐκκλησία* (ecclésia), which often occurs in the New Testament, which was adopted into the Latin language without any change, and which gives us our words ecclesiastics and ecclesiastical, which correspond to the Saxon terms churchmen, and of churchmen. The meaning of the word *ecclesia* among the classical Greek writers is "meeting or assembly," and in this or the somewhat modified sense of "community" it was adopted by the writers of the New Testament.

The whole community of Christians thus constitute the church. This is the sense in which the word is most commonly used in the New Testament: as when it is said that "the Lord added daily to the church such as should be saved" (Acts ii. 47); "Head over all things to his church" (Eph. i. 22); "concerning zeal, persecuting the church" (Phil. iii. 6); and when our Lord said, "Thou art Peter, and on this rock I will build my church" (Mat. xvi. 18), he contemplated that

majestic assembly, the multitude whom no man can number, who in ages to come should form the great Christian community. And as, when thus used by the Apostles, it comprehended all the disciples of Christ, without regard to questions which divided the opinions of Christians even in the earliest times, so it is still often used to denote the whole body of Christians, notwithstanding any peculiarities in their church order and ritual, or however they may understand the instructions on some points of Christ and the Apostles.

But it soon came to be regarded as essential to the idea of a church that the believers should be bound together by a species of mutual pledge, and form a compact and united body. Certain outward forms of profession came to be regarded as requisite for every member, such as baptism and partaking in the Lord's Supper; certain officers, as bishops, pastors, and deacons, were regarded as essential; as well as certain uniform services, and the acknowledgment of certain propositions as containing a just exposition and summary of the doctrine of Christ and the Apostles. A continued effort seems to have been making from a very early period in the history of Christianity to bring the body of professing Christians into this state of consistency and uniformity. And to give the greater effect to the effort, the bishop of Rome, who was represented as the direct successor of St. Peter, the rock on whom the church was to be built, received by almost universal consent a kind of headship, or supremacy, and about him was gathered a council, consisting of other bishops, pastors, and deacons, forming a supreme authority in this compact community, and a court of ultimate appeal. Up to the time of Constantine, the church had been independent of the State. By uniting the two, the church acquired rank and wealth—the state the means of influencing its rulers. Nearly the whole body of professing Christians in the states of western Europe were, by various means, brought to enrol themselves in this great confederacy, and they formed for many ages the church, a numerous and in the main a well-ordered and well-governed community. But the removal of the seat of empire led indirectly to the first great separation into the eastern and western churches, continuing to the present day under the forms of the Greek church and the Roman Catholic church.

At the Reformation, certain states of Europe separated themselves from the Western Church. The separation was made on various grounds: objections to the tyranny of the ecclesiastical authorities: to their exactions; to their assumption of powers not sanctioned by reason or Scripture; to the corrupt lives of some of the persons near the head of the church; together with an opinion that the ceremonies enjoined in the ritual were superstitious, if not idolatrous; and that many things were taught to the people as Christian verities which not only had no countenance from Scripture, but which were opposed to the plain teachings of Christ and his Apostles. Many of the leading reformers did not look to the disruption of the church, but to the reformation of it in doctrine and discipline, leaving the community of believers in the compact order in which they found them. But the resistance which was made to the efforts of the reformers, combined with other things, rendered this impracticable, and nothing remained for the states in which the call for reformation was the loudest, and where a strong sense of the corruption of the Roman Catholic system had possessed the minds both of rulers and people, but to break off from the great confederacy, and to renounce entirely all connection with and all spiritual allegiance to the pope, the great head of the church. Hence arose another use and application of this term *church*, and we hear of the Lutheran church, the church of Geneva, the church of Scotland, and the church of England, meaning the Christian members of those political confederacies, or belonging to those nations, when regarded under the aspect of being professed believers in Christ.

The expediency and the right of particular nations thus to detach themselves from the great community of Christians, and to establish churches of their own, have been subject of controversy. Protestants, or Reformers, however, regard the point as settled, and in all the Protestant states of Europe, there are *national churches* established, founded on the public law, and regulated by the same public will which regulates affairs purely political and secular. Those national churches of Protestantism vary among themselves on numerous points of order, ritual, and doctrine, according to the peculiar opinions of the persons who happened to possess the chief influence at the time when the new faith, form, and order were established, or who at a somewhat later period had influence sufficient to modify the church in any of these points. Hence there is no common church of Protestants. Each Protestant nation has its own church, and regulates its own spiritual affairs without communication with other Protestant people. It is a system of national independency. These national churches, however, are not found to comprehend all persons who in their political character are members of the respective nations. There are many who separate themselves from the national union because they object to the principle of a national church. They contend that there should be no such church regulated by councils and parliaments, but that the believers in Christ should be left at entire liberty, each person for himself to connect himself with others, if he sees proper to do so, and thus to form Christian communities on principles and for purposes such as each individual might approve for himself. The Congregationalists or Independents of England, the most numerous class of English dissenters, in the declaration of their faith, church order, and discipline, issued by authority in 1833, avow the principle that each society of believers associated together for religious purposes is properly a Christian church. The question about which there has been so much disputation, of the union of church and state, is in effect, and when stripped of its abstraction and its personification, nothing more than the question whether there shall be a union of the people of each nation in one Christian society, the affairs of which are regulated by the national will as that will is collected on other subjects; or, whether there shall be no expression of a common will, but each person be left to receive or neglect Christianity, and to make his public profession of it in whatever way seems to him to be the best. Our limits do not allow us to enter into the discussion of this question, but we may state the main arguments briefly thus: In behalf of a national church it is contended that without some public provision there would soon be many parts of the country without Christian ministrations at all; that by securing an order of well-instructed ministers, there is the best preservative that can be devised against the prevalence of injurious superstition and dangerous errors; that affairs of such importance as these should be subjected to the consideration and direction of the enlightened mind of a people; and that practically from the moment that property is acquired by any body of professing Christians, that body must become amenable to the state, must apply to the state for direction whenever questions arise respecting it, so that it is in fact impossible entirely to disjoin affairs of religion from affairs of state. On the other hand, it is contended that to set up articles of faith and forms of worship is an injurious invasion of the rights of Christians; that to connect the profession of particular opinions with temporal advantages is unfavourable to the progress of inquiry and of truth, and has a tendency to produce simulation in Christian ministers; that the system leads to political subserviency, and fosters a worldliness of spirit; and that practically the system is not acceptable to the nation, as is evinced by the number of persons who, notwithstanding the losses and inconveniences to which ,in consequence, they subject themselves, yet do not belong to the church.

The Methodists do not, we believe, speak of themselves as a church; but their system is in all its great features that of a Presbyterian church.

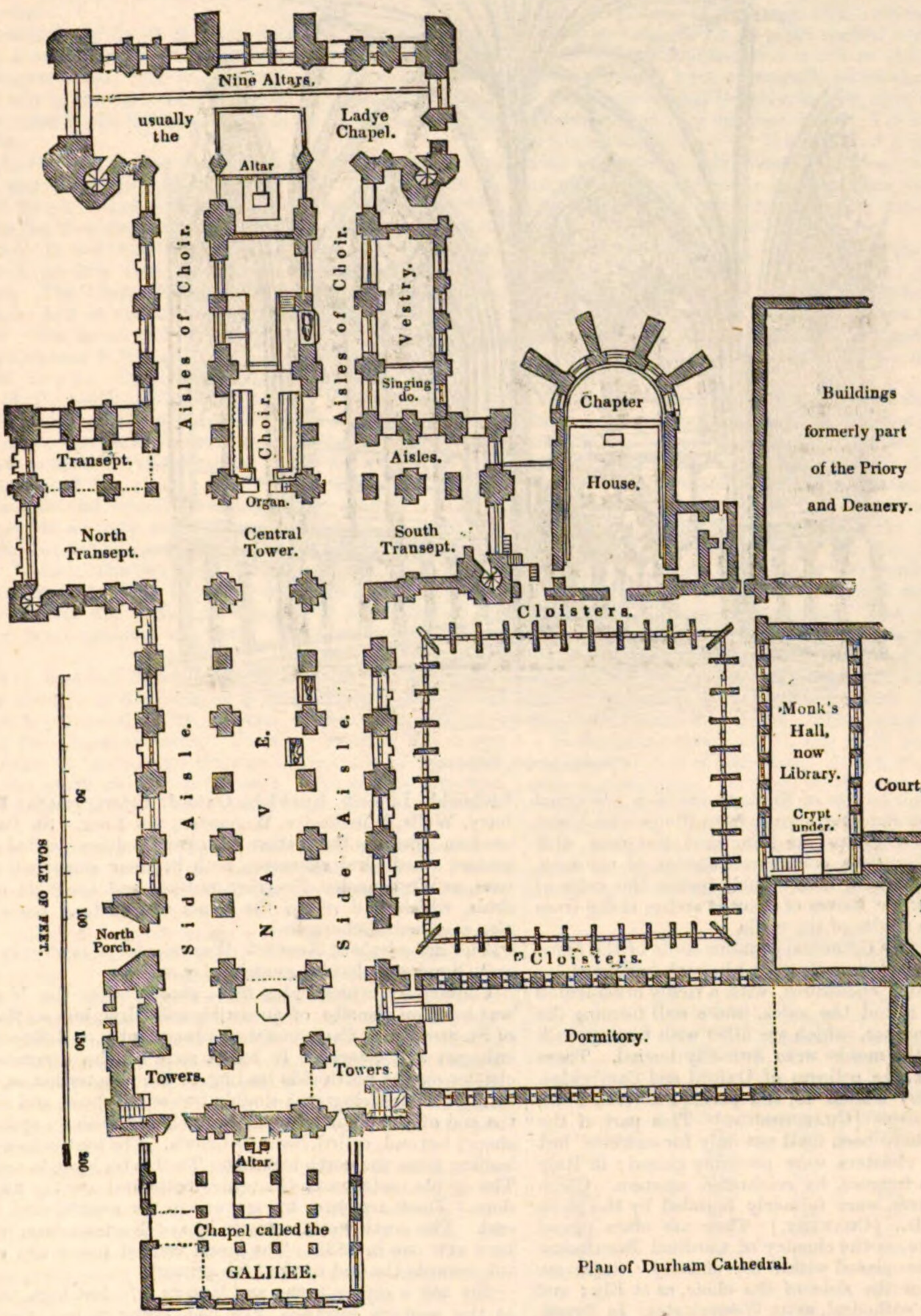
We have now gone through the principal senses in which this term *church* is used when it is applied with any propriety. But we cannot conclude without noticing one other sense in which the word is often used, and we notice it to condemn it as mischievous, and in every point of view incorrect and improper. We mean when *church* is used to denote *the officers of the church*, the bishops, priests, and deacons; a use of it neither sanctioned by etymology nor the usage of primitive times, and which is calculated greatly to mislead, as things which are predicated, and truly predicated, of the church in its proper sense of a community of believers in church order, and appointed with proper church officers, may be transferred inadvertently to *church* when it is the officers only who are meant. "The interests of the church," for instance, a very common phrase, are properly the interests of the great English community looked upon in the aspect of its relation to Christianity, not the interests of the officers or ministers only. Their proper designation is not the church, but the clergy.

CHURCH. An ecclesiastical edifice, sometimes built after the model of a modern basilica, sometimes in the form either of a Latin or a Greek cross, and sometimes, though much more rarely, circular in form. The basilica form however must be considered as belonging to the churches of the early Christians [BASILICA]; cruciform churches are of Romanesque date, and were almost universal during the prevalence of Gothic architecture. The origin of the difference between the form of the Latin and Greek cross belongs to the period of the division between the Eastern and the Western churches. [BYZANTINE ARCHITECTURE.] The Latin cross was in common use in the greater part of Europe until the Reformation. Some resemblance to the basilica form may be traced in modern churches erected since the Reformation to the revival of Gothic architecture.

A church or cathedral with a Greek cross has the transept as long as the nave and choir: the greater part of the Greek churches are built in this form. The Latin cross has the nave much longer than the transept and choir. The greater part of our older parish churches consist of a nave with aisles, a chancel (in the larger churches, a transept), and a tower sometimes at the intersection of the arms of the cross, but usually at the western end. Many of our modern churches, and particularly those constructed in the 18th, and early part of the 19th century, consist of only one long nave, with an altar at the east end; the cross form, or transept, is in some instances scarcely perceptible, and in others entirely omitted. In the nave of the church, towards the east end, are placed the pulpit and reading-desk, now almost invariably on one side, but during the prevalence of a semi-classic style often in the centre of the nave. The altar end of the church is raised by a step or steps, and is enclosed. The font is sometimes placed near the entrance, at others nearer the altar. Stoups, or small stone basins, set in niches and intended for holy water, were general in English churches before the Reformation, and are still often seen in village churches. Near the altar in ancient churches there are sometimes sedilia, or niches, with seats in them, raised each a step above the other. According to some ecclesiological writers the correct division of a church is into nave, chancel, and sacrarium.

Churches are of five classes, metropolitan, cathedral, collegiate, conventual, and parish churches. The term cathedral is derived from καθέδρα, 'a seat,' from the seat or throne of the bishop being placed therein. Cathedrals are the chief ecclesiastical structures of the dioceses in which they are situated.

Almost every cathedral is varied in plan, although the leading features, the nave and choir, are found in almost all. The plan usually consists of a galilee, or chapel, at the principal entrance; the nave or main body of the church; the side aisles, which do not rise so high as the nave, and are placed on each side of the nave, sometimes with chapels, at other times without, between the openings formed by the windows; the choir, or place for the ceremonies of the church; the transept, or division at right angles to the end of the nave next the choir, which projects on each side, and forms a cross on the plan. Some cathedrals have a double transept, and the transepts have often aisles. At the end of the choir is the high altar, behind which is

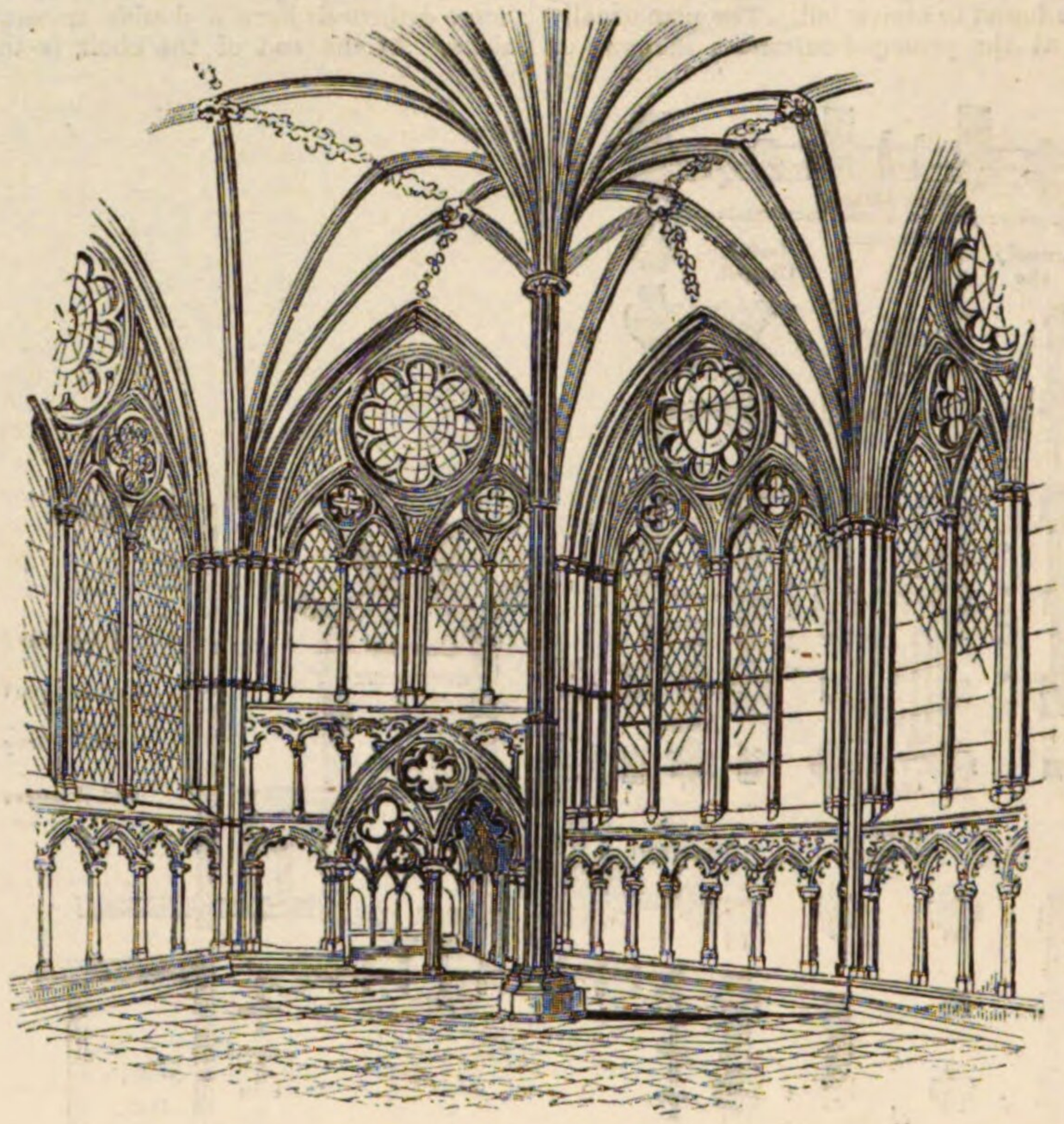


Plan of Durham Cathedral.

usually a lady chapel, or chapel to the Virgin. The choir end of a cathedral is sometimes terminated by an apsis, or semicircular end. Along the sides of the choir are ranged richly carved seats, ornamented with arches, pinnacles, and tracery, carved in oak. The bishop's seat, richer than the others and raised above them, is on one side, at the eastern end. The choir has also side aisles. Cloisters and a chapter-house are usually attached to English cathedrals, but the latter are more rarely met with on the Continent, the chapters being usually held in the cathedral, or in a chapel within the cathedral or abbey. The minor parts of a cathedral are the muniment room, the library, the consistory court, the vestries of the dean and chapter, minstrels' chapels, a font, and a minstrels' gallery.

Beneath the body of the cathedral there is usually a crypt, or low basement, supported on arches springing from thick columns, as in Canterbury Cathedral and others. Both externally and internally the ancient cathedrals of England, France, and Germany display all the magnificence of Gothic architecture. Like ecclesiastical buildings generally, they stand with the altar towards the east, and the principal entrance to the west; the transept is placed north and south. At the point of intersection of the transept with the nave there is usually a lofty tower, sometimes surmounted by an elegant spire, as in Salisbury Cathedral. Sometimes the principal or western front has a tower at each angle, and these in some instances are also terminated with spires. The nave of a Gothic cathedral is supported by clustered columns, arched from one to the other, over which there is usually a row of small arches forming a gallery, which is called the *triforium*, and above are windows called clerestory windows. The aisles are lighted by windows placed between the openings of the arches of the nave; and, externally, the buttresses of the aisles often rise, supported on an arch, to the wall of the nave: these are called flying buttresses. The exterior walls of the cathedral, with its towers, are generally decorated with buttresses, surmounted with pinnacles; and between the but-

tresses are the openings or windows of the nave and aisles. The ceiling of the nave is sometimes of stone, and covered with tracery formed by the intersection of the arches which spring from the clustered columns of the nave. The west or principal front is usually the most highly decorated with tracery, pinnacles, and sculptured figures. In the side aisles, and the aisles of the choir, there are often chapels richly designed, which contain the tombs of the founder, &c. Our cathedrals abound with monuments of various epochs, from the early Norman period of our history to the present time. The chapter-house and cloister are large and important features in many of our



Chapter-house, Salisbury.

cathedrals. The finest chapter-houses in England are of a polygonal form on the plan, with a seat running round from the entrance, and the interior decorated with sculpture, and in some instances with painting. In some chapter-houses a column, or cluster of columns, rises from the centre of the room, from which spring the sides of pointed arches, meeting the other halves of pointed arches rising from the column or columns at the angles of the walls.

The chapter-house of Salisbury Cathedral contains some of the finest specimens of the kind of sculpture usually found in such buildings.

The cloisters are rectangular enclosures, with a richly ornamented and arched gallery running round the sides, and a wall forming the back of the enclosure. The arches, which are filled with tracery, look into an area, where probably the monks were formerly buried. There are also cloisters in some of the colleges of Oxford and Cambridge. The cloisters seems to be very similar to, and perhaps derived from, the crypto-porticus of antiquity. [CHALCIDICUM.] This part of the ecclesiastical structure may have been used not only for exercise, but for study. In England the cloisters were probably glazed; in Italy they are often decorated with frescoes, by celebrated masters. Chantries, or chapels for singing mass, were formerly founded by the pious for the benefit of their souls. [CHANTRY.] They are often placed between the pillars of the nave, as the chantry of Cardinal Beaufort at Winchester; the effigy was also placed within the chantry. Some are complete chambers formed in the aisle of the choir, as at Ely; and others are independent of the cathedral, as at Westminster. In Byzantine churches [BYZANTINE ARCHITECTURE], and in some modern cathedrals and large churches, the principal feature is a dome, as Sta. Sophia, at Constantinople, St. Mark's at Venice, Santa Maria de' Fiori at Florence, St. Peter's at Rome, St. Paul's, London, the Pantheon at Paris, and many others.

Some parish churches have very much the form of a cathedral, as Christ church, Hants. The chancel of a church, which is sometimes the property of a layman, corresponds in situation to the choir of a cathedral, and, like it, is railed off from the body or nave of the church. [CHANCEL.] The chancels of our churches often contain the monuments of individuals connected with English history and literature, as at Arundel church, and Stratford-upon-Avon. In parish churches, however, the great tower is seldom placed at the intersection of the nave and transept, but forms the entrance at the west end, and contains the belfry.

The ancient cathedrals of England are Canterbury, Carlisle, Bristol, Chichester, Chester, Durham, Ely, Exeter, Gloucester, Hereford, Lichfield, Lincoln, Norwich, Oxford, Peterborough, Rochester, Salisbury, Wells, Winchester, Worcester, and York. St. Paul's, London, is modern. Besides these there are several edifices, called minsters, which possess a cathedral character both in their construction and in their uses, as Westminster, Beverley-minster, and Lichfield and York cathedrals, which still retain the name of minster. Abbey churches had also a cathedral character.

The cathedrals of Norwich, Westminster, Canterbury, Peterborough, and Gloucester, have a semicircular apsis.

Canterbury, which dates from shortly after the Norman conquest, was built on the site of an earlier cathedral, but on the model of that of St. Stephen at Caen, but was subsequently, at different times, greatly enlarged and altered. It has a nave of the decorated style, and a cloister on the north side leading to the chapter-house, which is in the form of a parallelogram; double transepts, choir, and side chapels. At the end of the choir is an elegant chapel, with an apsis, and a circular chapel beyond, called Becket's Crown. The font is in a circular chapel, leading from the north transept. To this building is attached a library. The crypts underneath the entire cathedral are the finest in the kingdom. There are three towers, one in the centre, and two at the west end. The north-western tower was of Norman date, but was replaced by a new one in 1832. The grand central tower was not commenced till towards the end of the 15th century.

Ely has a centre tower and lantern 170 feet high, and a fine tower at the western entrance, 215 feet high; it had two towers at the angles of the western entrance, but only one remains. The style of the building externally is Norman and Early English, or First Pointed. The nave, which is 72 feet high, and 75 feet wide, is a beautiful specimen of the Norman style, the elevation consisting of three tiers of arches, with long clustered shafts round each pier. The elevation of the choir internally presents a superb design of decorated English. It was erected, with the equally beautiful chapel of St. Mary between the years 1321 and 1349. The tower and lantern, supported on eight large piers, are unique among English Gothic churches. Ely lantern is said to have suggested to Sir C. Wren the idea of the lantern over the dome of St. Paul's. This cathedral has the lady chapel at one side, and not at the east end.

Salisbury is in many respects one of the finest English cathedrals, and the most uniform in style, having been commenced in 1220, and virtually finished about 1258: it is, therefore, a pure example of the First Pointed or Early English style. It has two transepts. The lady chapel has been, perhaps injudiciously, thrown into the choir. There

is a porch entrance on the north side, leading into the nave. The cloisters, which are very extensive and magnificent, lead into a very elegantly designed chapter-house. A small muniment-room is attached to the south end of the second transept. The grand central tower is supported by four massive piers, surrounded with smaller columns; and is surmounted by a singularly beautiful spire, which attains a height of 404 feet. This spire was added some time after the tower was finished; and the weight of it has considerably warped the piers, in consequence of which the summit of the spire is near two feet out of the perpendicular.

Hereford cathedral is chiefly of Norman date (1079–1115); it has a nave, side aisles, a north porch, two transepts, a choir, a lady chapel, cloisters, and a chapter-house. The architecture of the nave is Norman. The east end is built in the early English style. Underneath the lady chapel is a crypt; and at the intersection of the nave there is a very large square tower.

Worcester cathedral has a nave and side-aisles, north porch, double transepts, choir and side-aisles, and a lady chapel. On the south are the cloisters and king's school, and a chapter-house, circular within, and polygonal on the outside, with a column in the centre, as at Lincoln and Salisbury. It is similar in plan to Hereford cathedral, having two transepts, but no side aisles to the larger transept which intersects the nave. The chapter-house and cloister are situated like those of Hereford; and at the intersection of the nave there is a handsome tower. The interior of the nave is in the Early English style. The chapter-house is Norman.

Wells cathedral, in plan, differs very much from all the rest. The chapter-house is on the north side of the church; the cloisters are in the usual place, the south, but they have only three sides; the entrance to them is from under the south-western tower of the cathedral. Here we have two western towers, a north porch, and a transept, with side-aisles; and at the end of the choir a very elegant lady chapel, with a termination at the east end, somewhat similar to the apsis of a basilica. The western front is entirely covered with sculpture of exceeding beauty. (See the excellent monograph on 'The Sculpture of the West Front of Wells Cathedral,' by C. R. Cockerell, R.A.) The architecture of the nave is Early English: the towers are much later in style. The building was commenced near the beginning of the 13th century, but not completed till 1465. There is a crypt under this cathedral.

Exeter cathedral, founded in 932, rebuilt in 1112, has a chapter-house, used as a library, in the form of a parallelogram, unlike the usual form, which is polygonal. The cloisters of this cathedral were destroyed during the Commonwealth. The singularity of the design of this edifice consists in having two Norman towers, one at the north and the other at the south end of the transept. The nave is very fine, and in the early English style. The western front is richly adorned with statuary.

Bristol cathedral, founded about 1142, is inferior to many others: it is irregular and imperfect in the plan, being without a nave; but it has one of the finest Norman gateways in the kingdom, and there is some curious Norman work in the chapter-house.

Peterborough cathedral, rebuilt 1117, is on the plan of a simple Latin cross, with one large and two small towers at the western end, terminated with spires. The altar end of the choir has the termination in the form of the ancient apsis; the lady chapel is behind the altar. The transept has side-aisles and a tower at the intersection with the nave. The west end is remarkable for three large and deeply recessed arches, which form a magnificent and extremely picturesque portico; under the centre arch is a small porch, with a library over it. The style of this cathedral is partly Norman, mixed with Early English. Some parts are of a later date, as the east end, which is in the perpendicular or latest Pointed style.

Gloucester cathedral, rebuilt 1089, differs from the preceding. The apsis is very large: attached to this part of the building, and at the entrance of the side-aisles, are chapels: the lady chapel extends backwards. The chapter-house and cloisters are on the south side. On the north side of the cloister is a projection called a lavatory. On the south side is a beautiful porch. An elegant tower, in the perpendicular style, rises from the intersection of the nave and transept. The walls and columns of the nave are Norman.

Oxford cathedral is for the most part of Norman date. It has a short nave, a choir, a north transept, with an aisle, longer than the south transept, which is without aisles. A tower and spire rise from the intersection of the nave and transepts. Two large chapels on the sides of the choir cloisters, and a rectangular chapter-house, are attached on the south side.

Carlisle cathedral, formerly a priory, is small, and inferior to the other cathedrals. The oldest part is Norman, but the most noticeable feature, architecturally, is the great eastern window, which is a very rich and elaborate example of the Early English period.

Chichester cathedral was commenced in 1082. The nave is remarkable for having five aisles, there being no other example of the kind in England. It has besides the nave and transept, a choir, lady chapel, now a library, and an irregular enclosed cloister. There is also an isolated bell-tower, like the Italian campanile in principle. This cathedral has a lofty and very elegant spire. A large proportion of the shafts of the columns are of Purbeck marble.

Chester has a nave with side-aisles, and south transept, now a parish church; a choir and lady chapel at the east end; a cloister to the north, and a rectangular chapter-house, and school-room, to the north of the cloister. The chapter-house, which is rectangular, is much older than the cathedral; the cathedral being wholly perpendicular in style, while the chapter-house is decorated.

Lichfield, partly of Early English date, has a nave and choir, nearly the same length; a lady chapel, with a semi-octangular head or apsis; an aisle on one side of the transept; and a chapter-house with parallel sides terminated at two ends with semi-octangular figures; but it is chiefly remarkable for its great central and two western towers, all of which are surmounted with spires of rich and beautiful design, and which together form a singularly picturesque group.

York is somewhat irregular in plan, from its various parts having been constructed at very different dates. Yet it has a picturesque as well as a magnificent aspect. It consists of a nave with side aisles, a choir with side aisles, a lady chapel, a transept with double aisles, an elegant octangular chapter-house leading from the north transept, a superb centre-tower, two western towers, a record-room, and a consistory-court. There is also a small crypt.

Winchester is the longest, and altogether one of the largest cathedrals in England. It is constructed on a regular plan; the cloister was rectangular, but both it and the chapter-house have been destroyed. The transept is remarkable and unique, on account of the aisles running round the three sides. A small lady chapel is attached to the east end, and there are extensive crypts under the cathedral. The west front is very fine.

Lincoln is almost wholly Early English in style, and is one of the finest of our English cathedrals. It has a nave, a choir, and double transepts. Behind the choir is a presbytery: a small galilee is attached to the south transept. The cloister, which is comparatively small, leads to a magnificent chapter-house, of a polygonal figure, ten-sided, with flying buttresses. The western transept has aisles, and a large tower at the intersection with the nave. At the west entrance there are two smaller towers. The west front is richly adorned with sculpture. Lincoln cathedral is very perfect.

Norwich is Norman in plan, and the nave, central tower, and east end are of Norman construction. The cathedral consists of a long nave, and a transept; the east end is terminated by an apsis, beyond which there is a lady chapel, and at the side of the apsis are two chapels, formed by two segments of a circle. Attached to the side-aisle of the choir is a consistory-court. There are large cloisters on the south side of the edifice. The chapter-house has been destroyed.

Westminster abbey was in the main built between 1240 and 1269, but much of it is of later date. It consists of a long nave and transept, with double aisles, an apsis at the east end of the choir, with four semipolygonal chapels round it: beyond is the sumptuous chapel built by Henry VII. In proportion to its width it is the loftiest cathedral in England. The cloisters are to the south, as well as the chapter-house, an octangular building; beyond are some smaller cloisters connected by dark passages with the great cloisters.

A Comparison of the principal Measurements of the English and Welsh Cathedrals.

Cathedrals.	Extreme external length.	Extreme breadth.	Height of chief tower and steeple.	Length of Nave.	Breadth of Nave with Aisles.	Height of Nave.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Canterbury .	545	170	230	188	73	80
Bangor . .	223	96	60	141	60	34
Bath . . .	240	257	..	111	..	..
Bristol . .	203	127	133	..	..	..
Carlisle . .	242	130	123	110	71	73
Chester . .	375	200	127	120	74	78
Chichester . .	407	151	300	146	97	65
Durham . .	502	194	210	205	81	69
Ely . . .	535	190	266	203	81	74
Exeter . .	408	155	153	96	72	66
Gloucester . .	427	154	223	160	83	68
Hereford .	350	174	160	125	68	63
Lichfield . .	403	177	252	143	66	55
Lincoln . .	505	242	258	176	80	82
Llandaff .	300	80	..	..	65	65
Norwich .	415	200	309	205	76	75
Oxford . .	168	116	145	61	54	45
Peterborough .	480	198	143	234	79	78
Rochester .	383	170	156	140	66	55
Salisbury . .	474	230	404	196	82	84
St. Asaph .	178	108	93	84	68	60
St. David's .	307	..	124	124	68	..
St. Paul's . .	512	283	360	170	100	90
Wells . .	415	155	165	164	69	68
Winchester .	556	230	140	240	85	76
Worcester . .	425	145	193	174	78	67
Westminster	530	220	225	154	75	105
York . .	518	241	200	210	106	93

Rochester has a nave and side-aisles of Norman date, a double transept, but on the north side of the choir only, a choir, and a chancel at the end of it. The chapter-house is at the south-east, and in form is a long parallelogram. A low tower rises from the intersection of the transept and nave, and on the west is a chapel. It still retains its original Norman doorway, one of the richest examples of its kind existing in this country. The crypt is one of the finest remaining.

Bangor cathedral consists of a choir, nave, transept, aisles, and a quadrangular tower at the west end. The clerestory windows are circular: those below are pointed. Neither externally nor in the interior does it lay much claim to admiration.

Bath abbey, now a cathedral church, is in the form of a cross, making two small transepts without aisles; a small vestry is attached to the south transept, and a great tower rises at the intersection of the transept. The choir is the same width as the nave.

The cathedral of St. David's is partly Norman and partly of the pointed style. It consists of a nave, choir, transepts, side aisles, and a western tower.

St. Asaph's is small and plain, but not inelegant. It was built in 1284, but many alterations and additions were subsequently made. It is cruciform, with a central square embattled tower.

The numerous cathedrals of France, Italy, and Germany present beautiful specimens of architecture, not only in the Gothic, but also in the Italian style. The cathedrals of Amiens, Beauvais, Notre Dame de Paris, as well as many others, are noble examples of Gothic. Cologne, and Freiburg, in the Breisgau, are equal if not superior to any cathedral in England. St. Peter's is the largest cathedral in Europe. Vienna and Strasburg have the highest spires; the former is 465 feet, the latter 456 feet high.

CHURCH-BUILDING COMMISSIONERS were first appointed by the statute 58 Geo. III. c. 45 (which has, however, been amended by upwards of thirty subsequent acts), for building new churches in populous districts, and for dividing existing parishes, and assigning new ecclesiastical districts and determining their endowment and patronage, their recommendations being notified and carried into effect by orders in council. In this way, not only have new districts been carved out of existing parishes, and themselves considered as original parishes, but churches and chapels have in some cases been constituted the parish church, and the original parish church has become a district church or chapel of ease. The ministers of these districts are usually denominated *incumbents*, not being *parsons* and *vicars*, properly so called. The Church-Building Commission, although by the original Act limited to ten years, was from time to time extended; and the powers of the commissioners have been recently transferred to the Ecclesiastical Commissioners. (*Blackst. Comm.*, Mr. Kerr's ed., v. i. p. 398.)

CHURCH-RATES are rates raised, by resolutions of a majority of the parishioners in vestry assembled, from the parishioners and occupiers of land within a parish, for the purpose of repairing, maintaining, and restoring the body of the church and the belfry, the churchyard fence, the bells, seats, and ornaments, and of defraying the expenses attending the service of the church. The spire or tower is considered part of the church. The duty of repairing and rebuilding the chancel lies on the rector or vicar, or both together, in proportion to their benefices, where there are both in the same church. But by custom it may be left to the parishioners to repair the chancel, and in London there is a general custom to that effect.

The burden of repairing the church was anciently charged upon tithes, which were divided into three portions, one for the repair of the church, one for the poor, and one for the ministers of the church. Pope Gregory had enjoined on St. Augustine such a distribution of the voluntary offerings made to his missionary church in England; and when Christianity came to be established through the land, and parish churches generally erected, and when the payment of tithes was exacted, the tithes were ordered to be distributed on Pope Gregory's plan. Thus, one of Archbishop Ælfric's canons, made in the year 970, is as follows:—"The holy fathers have also appointed that men should give their tithes to the church of God, and the priests should come and divide them into three parts, one for the repair of the church, and the second for the poor, but the third for the ministers of God, who bear the care of that church." (Wilkins, 'Concilia,' i. 253.) The same division of tithes was enacted by King Æthelred and his councillors in witenagemot assembled, in the year 1014. A portion of the fines paid to churches in the Anglo-Saxon time for offences committed within their jurisdictions, was also devoted to church repairs. The bishops were likewise required to contribute from their own possessions to the repair of their own churches. A decree of King Edmund and his councillors, in 940, headed "Of the repairing of churches," says that "Each bishop shall repair God's house out of what belongs to him, and shall also admonish the king to see that all God's churches be well provided, as is necessary for us all." (Schmid, 'Gesetze der Angel-Sachsen,' i. 94.) One of King Canute's laws says, "All people shall rightly assist in repairing the church;" but in what way it is not said. There is no pretence, however, for interpreting this law of Canute's as referring to anything like church-rate. A payment to the Anglo-Saxon church, called cyric-sceat (church scot), has been erroneously identified with church-rate by some writers. This was a payment of the first-fruits of corn-seed every St. Martin's day (November 11), so much for every hide of land, to the church, and the laws of King Edgar and King Canute direct all cyric-sceat to be paid to the old minster. (Schmid, i. 99, 165.) Cyric-sceat was otherwise called cyric-amber, amber being the measure of payment. (See further 'Ancient Laws and Institutions of England,' printed under the direction of the Commissioners of Public Records, 1840.)

Churches continued to be repaired with a third of the tithes after the Norman conquest, and to as late as the middle of the 13th century. How the burden came to be shifted from the tithes to the parishioners is involved in much obscurity. The following conjectural sketch of the rise of church-rates is from a pamphlet by Lord Campbell: "Probably the burden was very gradually shifted to the parishioners, and their contributions to the expense were purely voluntary. The custom growing, it was treated as an obligation, and enforced by ecclesiastical censures. The courts of common law seem to have interposed for the protection of refractory parishioners till the statute of Circumspecte Agatis, 13 Ed. I., which is in the form of a letter from the king to his common law judges, desiring them to use themselves circumspectly in all matters concerning the bishop of Norwich and his clergy, not punishing them if they held plea in court Christian of such things as are merely spiritual, as 'si prælatus puniat pro cimeterio non clauso, ecclesia discooperta vel non decenter ornata.' Lord Coke observes, 'that some have said that this was not a statute, but made by the prelates themselves, yet that it is an act of parliament.' In the printed rolls of parliament, 25 Ed. III., No. 62, it is called an ordinance; but in the statute 2 & 3 Ed. VI. c. 13, § 51, it is expressly styled a statute, and it must now clearly be taken to be the act of the whole legislature. From the year 1285, therefore, the bishops were authorised to compel the parishioners by ecclesiastical censures to repair and provide ornaments for the church." (Sir John (now Lord) Campbell's 'Letter to Lord Stanley on the Law of Church-Rates,' 1837.) But for long after the existence of the custom of making the parishioners contribute to the repairs of the church, and after the statute Circumspecte Agatis, the original obligation on the clergyman to repair out of the tithes was remembered. Lord Campbell quotes in the same pamphlet a passage from a MS. treatise in the Harleian collection, written in the reign of Henry VII. by Edward Dudley, a privy councillor of that king, which thus lays down the law for appropriation of the incomes of the clergy: "One part thereof for their own living in good household hospitality; the second in deeds of charity and alms to the poor folk, and specially within their dioceses and cures, where they have their living; and the third part thereof for the repairing and building of their churches and mansions." Lyndwode, who wrote in the 15th century, says, that by the common law the burden of repairing the church is on the rector, and not on the laity. "But certainly," he adds, "by custom even the lay parishioners are compelled to this sort of repair; so that the lay people is compelled to observe this laudable custom." ('Const. Legatin.' 113.)

It may now be assumed as undoubted, that by the common law of this country the inhabitants of a parish are bound to bear the expense of keeping the parish church in repair; and the mode in which this obligation is performed is, in practice, by church-rates imposed by the parishioners themselves, at a meeting summoned by the churchwardens for that purpose. Upon the churchwardens, conjointly with the minister, devolve the care of the fabric of the church, and the due administration of its offices. With a view to provide a fund for such expenses, it is the duty of the churchwardens to summon parish meetings for the purpose of levying rates; and if they neglect to do so they may be proceeded against criminally in the ecclesiastical courts. A mandamus also is grantable to compel the churchwardens to call a meeting. They may also be punished by the ecclesiastical courts for neglecting to make repairs for which money has been provided by the parish; but if they have no funds in hand, and if they have not failed to call the parishioners together, they cannot be punished. If the parish fail to meet, the churchwardens then constitute the meeting, and may alone impose a rate; but if the parish should assemble, it rests with the parishioners themselves to determine whether they will make a rate; for a valid rate can only be made by an actual or constructive majority of the parishioners in vestry assembled, and if the majority should refuse to make a rate, the minority cannot make it. (Gosling *v.* Veley, 4 House of Lords Cases, p. 679.)

The repair of the parish church, and the provision of the necessaries for divine service, are thus, to a great extent, at the option of the majority of the parishioners assembled. Before the Reformation, the parishioners could be punished in the ecclesiastical court for failing to repair the parish church; and the punishment was, to place the parish under an interdict, or sentence of excommunication, by which the church was shut up, the administration of the sacraments suspended, and any parishioner who died was buried without bell, book, or candle, and the sentence of excommunication and interdict may still be obtained in the ecclesiastical courts. But there are now no means of compelling the parishioners to provide church-rates. There is no remedy by mandamus: the Court of Queen's Bench will grant a mandamus, as has been already said, directing churchwardens to call a parish meeting, but not to compel parishioners to make a rate. The ecclesiastical courts cannot make a rate, nor appoint commissioners to make one.

The existing poor-rate of the parish is generally taken as the criterion for the imposition of the church-rate; but decisions as to poor-

rates are not binding in case of church-rates, and the proper test for church-rates is a valuation by competent judges, grounded on the rent the tenant would be willing to pay for the premises. All property in the parish is liable except the glebe-land of that parish, and the possessions of the crown when in the actual occupation of the crown, and places of public worship. Stock in trade is not generally rated for church repairs, but a custom may exist rendering it rateable in a particular parish. A ratepayer cannot, by an original proceeding in the ecclesiastical courts, raise objections to a rate for the purpose of quashing it altogether. If he wishes to dispute it, he ought to attend at the vestry, and there state his objections; if they are not removed, he may enter a caveat against the confirmation of the rate, or refuse to pay his assessment. In the latter case, if proceeded against in the ecclesiastical court, he may in his defence show either that the rate is generally invalid, or that he is unfairly assessed. The consequence of entering a caveat is an appeal to the ecclesiastical judge, who will see that right is done.

A retrospective church-rate, or rate for expenses previously incurred, is bad. This has been often decided in the courts of common law and equity, and in the ecclesiastical courts. The reason is stated by Lord Ellenborough in the judgment of the court in Rex *v.* Haworth (12 East, 556):—"The regular way is for the churchwardens to raise the money beforehand by a rate made in the regular form for the repairs of the church, in order that the money may be paid by the existing inhabitants at the time, on whom the burden ought to fall."

Previously to 53 Geo. III. c. 127, the only mode of recovering church-rates from parties refusing to pay the amount of the rate, was by suit in the ecclesiastical court for subtraction of rate. By that statute, where the sum to be recovered is under 10*l.* (or in the case of Quakers, 50*l.*), and there is no question as to the validity of the rate, or the liability of the party assessed, any justice of the county where the church is situated may, on complaint of the churchwardens, inquire into the merits of the case, and order the payment. Against his decision there is an appeal to the quarter-sessions. The period of imprisonment for non-payment is limited by the 12 & 13 Vict. c. 14, to three calendar months. By several statutes, principally the 58 Geo. III. c. 45; 59 Geo. III. c. 134; and 3 Geo. IV. c. 72, Acts passed for the promotion of building churches, the common-law powers of churchwardens have been varied, and extended so as to enable them to raise money on the security of church-rates, and to apply them for the enlargement, improvement, &c. of churches, and for the building of new ones, &c.

The levying of church-rates on dissenters, who are so numerous in this country, has caused so much irritation, and the frequently successful opposition of dissenters at vestry-meetings called to impose rates has rendered church rates so precarious a resource, that various attempts have been made for the last quarter of a century to abolish them, and to substitute some more certain and less obnoxious provision for the repair of churches and the due celebration of divine worship. Although hitherto unsuccessful it is probable that no very long time will now pass without a definitive settlement of the question. There are endowments in many parishes for the repair of the church, which render church-rates unnecessary; and in many parishes arrangements have been made for voluntary subscriptions, to avoid conflicts between churchmen and dissenters, and the scandal of such disputes.

Some returns laid before Parliament in 1859, give the following particulars: annual average of amount expended during the previous seven years for church purposes, 635,881*l.* 12*s.* 4*d.* Amount, how expended—on the repair and maintenance of the church and churchyard, 336,564*l.* 12*s.* 8*d.*; for the celebration of divine worship, 173,426*l.* 6*s.* 2*d.*; for other purposes, 95,565*l.* 8*s.* 9*d.* Amount, how raised: by church-rates, 263,709*l.* 14*s.* 9*d.*; by special endowments, 48,274*l.* 17*s.* 3*d.*; by voluntary rates or subscriptions, 269,550*l.* 8*s.* 1*d.*

CHURCHWARDENS, are parish officers, who by law have a limited charge of the fabric of the parish church, of the direction and supervision of its repairs, and of the arrangement of the pews and seats. Certain other duties are imposed upon them on particular occasions. There are usually two churchwardens in each parish, but by custom there may be only one. It is said by some authorities, that by the common law the right of choosing churchwardens is in the parson and the parishioners. This is, however, by no means universally the case, as a custom prevails in many parishes for the parishioners to choose both, and in some, both are elected by a select vestry. The eighty-ninth canon of 1603 directs that "churchwardens shall be chosen yearly in Easter week, by the joint consent of the minister and parishioners if it may be; but if they cannot agree, the minister shall choose one and the parishioners another." It has, however, been questioned how far these canons are binding upon the laity, even in matters ecclesiastical.

Provision is made for the appointment of churchwardens for modern churches and chapels and new parishes, by several of the Church Building Acts.

The usual duties of churchwardens are, to take care that the churches are repaired, and for that purpose to make and levy rates; to distribute seats among the parishioners, under the control of the ordinary; to maintain order in the church during divine service; and to provide the furniture for the church, the bread and wine for the sacrament, and the books to be used by the minister in conducting

public worship. The churchwardens are by virtue of their office overseers of the poor; and they are also required to present to the bishop all things presentable by the ecclesiastical laws, which relate to the church, minister, or parishioners. In large parishes there are sometimes officers called sidesmen (*synodsmen*) or questmen, whose business it is to assist the churchwardens in inquiring into offences and making presentments. Churchwardens and sidesmen were formerly required to take an oath of office before entering upon their respective duties; but by a recent statute, 5 & 6 Will. IV. c. 62, s. 9, they make and subscribe a declaration before the ordinary, that they will faithfully and diligently perform the duties of their offices.

If churchwardens are guilty of any malversation, or refuse to account to the parishioners at the termination of their period of service, they may be proceeded against summarily before the bishop by any parishioner who is interested, or the new churchwardens may maintain an action of account against them at common law.

Under the stat. 59 Geo. III. c. 12, churchwardens and overseers are empowered to take and hold lands in trust for the parish as a corporate body; and by a decision under this act, they can also take and hold any other lands and hereditaments belonging to the parish, the profits of which are applied in aid of the church rate. (Burn's 'Ecclesiastical Law,' tit. 'Churchwardens;' Blackst. 'Comm.,' Mr. Kerr's ed., vol. i. p. 400.)

CHURN. [BUTTER.]

CICERO'NE, a name given by the Italians, especially of Naples and Rome, to the guides who show travellers the antiquities of the country. It was a common saying in Italy, when speaking of a learned or eloquent man, "é un Cicerone," "he is a Cicero;" and the poor guides and valets de place, who, generally speaking, are neither learned nor eloquent, and often make ridiculous blunders on the most trivial subjects, have now usurped the name of Cicerone. It is also the name for printing-type of a particular size.

CICISBE'O, in Italian, means a gallant, a man who courts the ladies. The term is also applied to a knot of ribands, which used to be worn appended to the hilts of swords or to the handles of fans. ('Dizionario della Crusca.') In like manner a Cicisbeo is a man who hangs upon a lady, is constantly by her side and at her beck, and attends her wherever she goes. This derogatory custom long prevailed with married ladies, especially in towns and among the fashionable classes, in Italy, but the practice is now almost entirely discontinued. The words *cavalier servente* and *patito* are also used in the same sense. The words *cicisbeo* and *cicisben* are used to express male or female coquetry.

CICUTINE. An alkaloid of unknown composition, said to exist in hemlock.

CIDER, or CYDER. A word used to signify the juice of apples expressed and fermented. The article APPLE contains a general view of the culture of apple-trees; what is here stated as to the management of apple-trees has special reference to the English cider counties.

In the Hereford district (under which name we shall refer to that county with the adjoining cider districts in Gloucestershire, Monmouthshire, and Worcestershire, while by the name of the "Devonshire district" similar portions of Dorsetshire, Somersetshire, and Cornwall, will be distinguished), where the varieties of cider-apple cultivated are far more numerous than in any other part of England, the New Foxwhelp (a seedling from the old), the Wilding, the Cherry Pearmain, the Yellow and Red Norman,* are among the many sorts that are preferred. It appears to be almost immaterial whether the crab-stocks are grafted before or within a short time after they are removed from the nursery to the orchard in which they are to stand. In Herefordshire it is usual to insert the grafts about six feet from the ground, and to plant the trees about 66 feet between the rows, and 36 between the trees where the soil is rich; if the soil is poor, less distance is allowed, as the trees will not spread with so great vigour. This seems a preferable method to that practised in Devonshire, where the grafts are inserted at from three to four feet from the ground, and the trees planted about 16 feet apart. The advantage which in Devonshire is gained from the trees being less exposed and broken by the wind, and perhaps from a greater produce of apples, is more than counterbalanced by the entire loss of the land, usually a wilderness of weeds, into which horses run in the winter, and calves in the spring, but where neither grown cattle nor the plough can ever be admitted. In the Devonshire district, the situations chosen for orchards are generally hollow dells or shelving banks, in the neighbourhood of the farm-houses, the land on which they are planted being put to little other use; while in the Herefordshire district the choice is determined chiefly by the quality of the soil, without reference to the position of the farm-house. In their youth, the trees do comparatively little injury to the land, while they receive considerable benefit from the frequent stirring by the plough of the soil round their roots, so that newly ploughed lands, or hop-yards which may be again laid down to grass as soon as the trees have acquired some strength, are spots frequently chosen. This practice is agreeable to the very sensible instruction given by Mr. Marshall ('Rural Economy of Gloucestershire'): "Plant upon a recently broken-up worn-out sward; keep the soil under a state of arable management until the trees be well grown, then lay it down

* It has been objected to Norman cider, that it will not carry to a distance without damage.

to grass, and let it remain in sward until the trees be removed and their roots decayed, when it will again require a course of arable management" (vol. ii., p. 302).

In February or March, or, where the soil is light, in October or November, holes should be dug about six feet in diameter, each being adapted in depth to the root of the tree that it is to receive. The best earth, with the turfs, if the spot is grass land, should be thrown into the bottom of the hole, and the roots of the tree separated with the hand in horizontal layers, with the richest mould between them; all the earth may then be thrown in and firmly trodden down. If the stocks are strong, the best and cheapest method of protection from the injuries of cattle is a frame of willow staves, about six feet long, cleft as those used for the bars of hurdles; these should be hammered about six inches into the ground, round the tree, and as near it as can be done without injuring the roots, perhaps three inches from it; the staves should then be nailed together with two bands of narrow iron hooping, one a foot and a half from the bottom, another at a like distance from the top, at the same time binding them round the tree as tightly as can be done without injury to the bark. Where the stocks are not strong, the best fence is "one large post, slit with a saw and placed flat-way, with the faces to the plant, and about two feet apart, with rails on each side, nailed upon the edges of the posts." (Marshall.) In the Hereford district these fences are much used; they are cheap and effectual, and from their narrowness offer little impediment to plough-ing and other purposes of agriculture, which are here carried on as much in the orchards as in any other lands.

Very little attention is paid to enriching the soil round the trees when once they have been planted. In Devonshire it is common to see the weeds which are cropped in the orchards heaped near the stem, there to decay and nourish the roots; and in Herefordshire the more careful planters cause the earth to be dug once a year round trees that have been recently planted; neither is there so much care taken with the trees themselves when they have once grown strong, as the benefits which have been derived from a better system of management would warrant. In by far the largest proportion of orchards, with the exception of gathering the fruit, nothing is done to the trees from the beginning of the year to the end. To remove superfluous wood by judicious pruning (an art of which many that practise it are most mischievously ignorant), to remove part of an excessive crop of fruit, to cleanse from moss and mistletoe, which latter in frosts forms excellent food for sheep, are practices too frequently neglected.

The fruit of the different varieties of apple ripen at different times of the year, earlier or later, according to the season. Among the earliest are the Codling and American Must, which begin to fall from the trees at the end of September; and while the majority attain their maturity about the end of November or the middle of the following month, there are some from which the apples will not fall until six or eight weeks later. The customary method of picking the fruit is by striking the trees with poles, provincially called "poulting," and then gathering the fallen apples; but though this practice is almost uni-versal, it is frequently mischievous, from the young bearing wood being broken by the violence that is used. It is better economy to pay a small extra price for collecting the fruit which falls at several times, than to injure the trees by knocking down all the fruit, the unripe as the ripe, to save a few shillings. The apples will fall by degrees, and at intervals a boy may be sent into the trees to shake the branches; in all practicable cases the use of the pole should be avoided. When the apples have been gathered, each sort by itself is collected into heaps, about ten inches deep, where they remain for a month, or more, until they become mellow; they are then ready for the mill.

Cider is manufactured with very rude machinery, by the following process: The apples are thrown into a circular stone trough, usually about 18 feet in diameter, called the *chase*, round which the *runner*, a heavy circular stone, is turned by one or sometimes two horses. When the fruit has been ground until the rind and the core are so completely reduced that a handful of "must," when squeezed, will all pass without lumps between the fingers, and the maker sees from the white spots that are in it that the pips have been broken, a square horse-hair cloth is spread under a screw-press; and some of the must is poured with pails upon the hair, the edges and corners of which are folded inwards so as to prevent its escape. Ten or twelve of these hairs are piled and filled one upon the other, and then surmounted with a frame of thick boards.* Upon this the screw is slowly worked down by a lever; and with the pressure, a thick brown juice exudes from the hairs, leaving within them only a dry residue, which, in years when apples are scarce, is sometimes mixed with water, ground again, and the liquid pressed out as before. This latter product is called "water cider," a thin unpalatable liquor, which is given to the labourers early in the year.

The cider is received by a channel in the frame of the press upon which the hairs stand, emptying into a flat tub called a "trin." From the trin it is poured with buckets or "racking cans" into casks, placed either out of doors or in sheds where there is a free current of air. In

* This is the process in the Hereford district. In Devonshire a lever press is used, and "reed," unthrashed straw, is placed in layers in the place of hairs. The method used in the south of France for expressing oil from olives is identically the same.

about three or four days, more or less according to the heat of the weather, the liquor usually will ferment; the thick heavier parts will subside as a sediment at the bottom of the cask, and the lighter become bright clear cider. This should then be "racked" or drawn off into another cask, and the sediment be put to strain through linen bags, and what oozes from them should be restored.

It is during the fermentation that the management of cider is least understood, and there is the greatest hazard of injury. It is necessary also to know what fruit will by itself made good cider, which kinds should be ground together, and what proportions should be mixed. But it is in preservation of the strength and flavour after the cider is ground that the principal difficulty consists: *slight* fermentation will leave the liquor thick and unpalatable; *rapid* fermentation will impair both its strength and durability; *excessive* fermentation will make it sour, harsh, and thin. Other things being equal, that cider will pro-bably prove the best in which the vinous fermentation has proceeded slowly, and has not been confounded with the acetous. The remedies used in cases of cider not clearing are either yeast or the addition of cider in a state of fermentation, isinglass, eggs, or a quart of fresh blood stirred up with the liquor, in which last case it is to be racked on the following day; these do not always prove effectual. But the common evils are excess or rapidity of fermentation; and if a better quality than farm-house or "family drink" is sought, cider requires so much care to prevent its being spoiled, that the best and most careful makers frequently have it looked at during each night for some weeks after it is made; and if the bubbling, hissing noise, the sign of fer-mentation, becomes frequent or too loud, the liquor is *immediately* racked off into another cask: this check often requires to be repeated several times; but although at each racking some portion of the strength will be lost, the body, flavour, and sweetness will chiefly be retained. It is not the habit of the farmer to add sugar, treacle, brandy, or any colouring matter to the liquor; it is only adulterated in the hands of cider dealers and publicans, who will not lose a hogshead, and if one has turned sour, or has been otherwise damaged, it must be "doctored,' in order to render it marketable.

At the beginning of January the cider is moved into cellars, where by large growers it is frequently stored in casks of great capacity, con-taining 1000, 1500, or even 2000 gallons; these are cheaper in pro-portion than smaller vessels, and are thought to preserve the cider better. In March the liquor is bunged down; it is then fit for sale, and may be used soon afterwards, though it will greatly improve by keeping. If bottled cider is required, it should be bottled and wired in the September or October after it is made; some persons prefer an earlier time, the end of April or the beginning of May; a greater degree of effervescence is thus attained, but a considerable loss accrues from the number of bottles that will burst.

In 1830 the tax upon cider of 10*s.* a barrel was taken off (M'Culloch, 'Dic. Com.'), and in the same year an Act was passed allowing any person to sell cider upon the payment of 2*l.* 2*s.* annually for a licence from the Excise. This Act was amended in 1834, and a licence for the sale of cider is now granted by the Excise to an application signed by six ratepayers of the applicant's parish, the payment being 3*l.* 3*s.* if the liquor is to be drunk on the premises, 1*l.* 1*s.* if it is not. These alterations have necessarily added greatly to the consumption; but the increase of orchards, and productive seasons, have fully supplied the demand. At present, the price in the hands of the grower may be thus estimated: Of the best cider, from 1*s.* to 1*s.* 6*d.* per gallon; good, from 8*d.* to 1*s.* per gallon; family cider, used by farmers and in public-houses, from 4*d.* to 10*d.* per gallon; 'drink' for labourers, from 2½*d.* to 6*d.* per gallon. These prices amply remunerate the farmer, who, in many instances, might increase his profits by a diminution of the cost of production. It cannot certainly be supposed that small growers can go to the expense of procuring much machinery; never-theless, the extreme clumsiness of the present wasteful system would fully warrant larger owners in erecting suitable buildings and apparatus. It is true that some improvements have been made, that larger mills are used, that in the press an easily worked iron screw has been sub-stituted for an awkward wooden one; but far more remains to be effected. If the mill was placed upon a first floor, which could easily be done in a building erected against a bank, or having an inclined plane, so that horses might enter at that height, all lifting of the cider from the trin might be saved, as a pipe might be carried from the press into casks in the cellar underneath. Again, if the casks in the cellars were placed upon stages, manual labour in racking might be dispensed with, and waste from spilling saved, since a pipe from a hogshead upon a high stage would empty the liquor into a cask on a lower. No use, again, is made of the syphon, a cheap instrument within the reach of any farmer's purse, which would no doubt be serviceable and economical.

The quantity consumed by workmen is very large: two or three quarts a day is the usual allowance given in Herefordshire by masters; and in harvest-time many labourers drink in a day ten or twelve quarts of a liquor that in a stranger's mouth would be mistaken for vinegar; they do not like sweet cider. Notwithstanding so great a quantity is consumed, there do not appear to be any diseases peculiar to or very general in cider countries; idiotcy and rheumatism have been stated to be very prevalent in such districts; but even if this be true, cider-drinking has in no way been proved to be the cause.

Cider of good quality is made in Ireland, in the counties of Waterford and Cork; in Normandy, whence we have many of our best apples; in Belgium; and of inferior quality in Germany. It is also made in abundance, and of excellent quality, in many parts of the United States.

CIGAR MANUFACTURE. Referring to the NATURAL HISTORY DIVISION of the ENGLISH CYCLOPÆDIA for an account of the botanical characteristics of the tobacco plant, and to the article TOBACCO in the present division for a notice of the manufacturing and commercial relations of the trade generally, we will in this place briefly describe the production of cigars and cheroots.

The finest tobacco is rarely smoked in pipes; or, more properly speaking, the produce of Havannah and Manilla is made up into cigars and cheroots rather than into pipe-tobacco, while that of the United States is more frequently smoked in the pipe. The English dealers purchase tobacco by the hogshead, and set aside for cigars such leaves as appear best suited for that purpose. A boy, seated on a stool, takes up an unstripped leaf, folds it, strips off the stalk by a quick and dextrous movement, throws the stalk on one side, and lays the stripped leaf smoothly on a table. When a heap has thus been collected, a cigar-maker proceeds with his manipulations. He sits in front of a table, takes a leaf of tobacco, spreads it out smoothly, and cuts it into a form something like that of one of the gores or stripes in a balloon. He takes up a few fragments of tobacco-leaf, lays them on the spread leaf, and rolls them up with it into a cigar-form. He next places this cigar against a guage or guide, and cuts it to a given length. Finally, he lays a narrow strip of leaf on the table, and rolls the cigar spirally in it, twisting one end to prevent the leaf from becoming loosened. When the cigars have thus been made, they are dried in different ways, according to the time when they are wanted for sale.

The enormous duty on imported foreign cigars (9*s*. per lb.), renders it expedient to import the leaf, and manufacture the cigars in England; and this branch of industry has consequently become very extensive. Nevertheless, Cuba or Havannah cigars are preferred by those who can afford to pay for them, on account of their superior flavour. Cigars are largely made in Germany, and in many other parts of the Continent; but these are not very extensively smoked in England. The imported cigars are chiefly from Havannah, Manilla, and Bengal—the last named being by far the least esteemed of the three. A few years ago, the following particulars were given of the cigar-trade at Havannah, in the island of Cuba: "The greatest manufacturers of Havannah cigars are Cabañas, Hernandez, Silva, and Rencareiul; there are a hundred others of less note, who make from 10,000 to 100,000 a day. The cigar is composed of two distinct parts, the inside and the cover. For these, two different kinds of leaves are used; of which that for the cover is generally finer in texture and more pliant [than that for the inside]. These leaves are damped the night previous to their being made up; when rolled, they are placed on a large table, where they are divided into the various qualities of first, second, third, &c., and priced accordingly. Those which are most carefully rolled are called *Regalias*, and are sold at 22 to 26 dollars per thousand; while the second best, which are of the very same tobacco, and made by the same man, only with less care, are sold at 14 dollars; and others are done so low as 6 dollars. D. Hernandez employs about fifty men in his manufactory. Of the best common cigars, a workman can make a thousand a day; of the Regalias six hundred. The daily issues from that immense *fabrica* are about 30,000 cigars; which at 14 dollars per thousand would give nearly 100*l*. per day. They pay an export duty of half a dollar per thousand, and an import duty in England of nine shillings. The very best in quality do not find their way to Europe; because they are not fashionable; they are generally dark-coloured; whereas, a light-coloured and smoothly rolled cigar is preferred to the strong and highly flavoured rough ones, which are the best." Mr. M'Micking gives the following account of the great cheroot-manufactory at Manilla, in the Philippine Islands, belonging to the Spanish government. Cheroots, it may here be observed, are cigars cut off at both ends, instead of having one end pinched or screwed into a point: "In making cheroots women only are employed; the number so engaged in the factory at Manilla being generally about 4000. Besides these, a large body of men are employed in the composition of cigarettes, or small cigars, kept together by an envelope of white paper instead of tobacco; these being the kind most smoked by the natives. The flavour of Manilla cheroots is peculiar to themselves, being quite different from that of any other kind of tobacco; the greatest characteristic probably being its slight soporific tendency, which has caused many persons in the habit of using it to imagine that opium is employed in the preparatory treatment of the tobacco—which, however, is not the case. The cigars (cheroots) are made up by the hands of women in large rooms of the factory, each containing from 800 to 1000 persons. They are all seated or squatted, Indian-like, on their haunches upon the floor, around tables, at each of which there is an old woman presiding to keep the young ones in order—about a dozen of them being the complement for one table. All of them are supplied with a certain weight of tobacco, of the first, second, or third qualities used in making a cigar, and are obliged to account for a proportionate number of cheroots, the weight and size of which by these means are kept equal. As they use stones for beating out the leaves on the wooden tables, before which they are seated, the noise produced by them is deafening, and generally sufficient to make no one desirous of protracting a visit to the place. The workers are well recompensed by the government. As very many of them earn from 6 to 10 dollars a month for their labour, and as that amount is amply sufficient to provide them with all their comforts, and to leave a large balance for their expenses in dress, &c., they are seldom very constant labourers."

Patents are occasionally taken out for novelties in cigar making; but not in any great number. A Liverpool house has purchased the use of a machine patented in America, by which cigars can be made at the rate of 5000 a day, with economy of tobacco. One of the strangest patents on this subject was obtained in 1852; it was for a method of using a hollow drill to make a hole through the cigar from end to end; drawing out the tobacco-dust from the hole by an exhausting apparatus; and lining the hole with a tube of amber or gutta percha, or varnishing the interior of the hole with liquid amber by means of a camel-hair pencil—all to make the cigar smoke more readily!

Of the extent of the cigar trade, there are no very trustworthy data; partly in consequence of the unequal degree to which cigars are included with other kinds of tobacco in the official returns. It is estimated that about 150 million cigars are annually shipped from Havannah to various countries. Great Britain imports from 2,000,000 to 3,000,000 lbs. of cigars, snuff, and manufactured tobacco annually—not one-twentieth part of the weight of *un*manufactured leaf imported; but as the cigars are not distinguished in the tables from snuff and manufactured tobacco, the weight of the cigars alone cannot here be stated. Real foreign cigars are sometimes surreptitiously imported in such a way as to evade the duty; but more frequently deception is practised by selling cigars, made in London, or Bristol, or Liverpool, so packed, that—in the shape of the boxes, the words and symbols branded thereon, and the mode of fastening the cigars into bundles—they may present the appearance of having been imported from abroad. An enormous preponderance of the so-called Havannahs, Mexicans, Manillas, Regalias, Lopez, Cubas, Silvas, Hernandez, Principes, Frangancias, &c., sold in London, are made in the neighbourhood of Whitechapel, and have no claim whatever to the names they bear; if sold at from 12*s*. to 24*s*. per lb., they are probably made of real tobacco, of varying qualities; but the cheaper cigars and cheroots are wretched compounds of damaged tobacco, lettuce-leaves, and even brown-paper, soaked in solutions of treacle, salt, saltpetre, colouring matter, and other substances.

Besides the cigars of ordinary make, there are medicinal cigars, prepared in reference to the requirements of the healing-art. Many kinds of medicine are made up in this form. Sometimes the leaf of a medicinal plant is made up like a cheroot, and smoked by the invalid for whom the medicament is intended; or the tobacco of a common cigar is medicated by steeping in a particular liquid; or a medicated paper is wrapped round a common cigar; or the narcotic property is taken out of a tobacco-leaf before it is made up into a cigar. In one or other of these ways are made aromatised, aromatic, scented, arsenical, balsamic, belladonna, camphor, mercurial, stramonium, and other cigars. Aromatised cigars and aromatic cigarettes are made chiefly for yielding an agreeable odour, the scent-giving substance being such as tincture or bark of cascarilla, gum benzoin, storax, oil of cloves, oil of cassia, &c.; but usually, these medicated cigars are intended, by their smoke, to alleviate tooth-ache, cough, asthma, hoarseness, typhus fever, scarlet fever, &c.

CIMBRI, or KIMBRI, the name given by the Roman and Greek historians to a vast multitude of people who came from the northern parts of Germany at the same time as the Teutones, crossed the Rhine, and entered Gaul, where they joined the Ambrones, a Celtic tribe, and after ravaging and plundering part of Gaul, went into Spain, where they were repulsed by the Celtiberi. (Livy, 'Epitome,' lxvii.) The Teutones and Ambrones then made an irruption into Italy, where they were defeated by Marius, near Vercellæ, 102 B.C. Part of the Cimbri, however, had gone into Helvetia, where they were joined by the Tigurini, a Helvetian tribe, with whom they crossed the Pennine Alps, and, after defeating the pro-consul Catulus, entered the plains of Lombardy, where they were defeated by Marius in the year after the Teutones and Ambrones, 101 B.C. From that time little or no mention is made of the Cimbri in history, but tradition says that the remnant of them settled in the central valleys of Helvetia, and the inhabitants of the Waldstätten and of the Bernese Oberland are supposed to be their descendants. Old Scandinavian words are traced in the dialect of these mountaineers. Of the original residence of the Cimbri we know nothing certain. Strabo (vii. 291–4) places them north of the Elbe beyond the Chauci, and numbers them among the German tribes. Pomponius Mela (iii. 3) places the Cimbri and Teutones in the islands of the Baltic Sea. Pliny speaks of the promontory of the Cimbri; and the peninsula of Jutland has been called Chersonesus Cimbrica, without, however, it being proved that the Cimbri ever inhabited it. Tacitus says that they "lived in the same winding tract of Germany as the Cheruscans" ('Germania'), 371. Plutarch ('Caius Marius') supposes that a great part of the force which opposed Marius were Scythians; and says they were designated as Celto-Scythians; but deems the more probable conjecture to be that they were composed of Germanic nations from the shores of the Northern Ocean. Most of the ancient writers concur in deriving them from about the

peninsula of Jutland, and in stating that they came from the north. They are, however, by some authors, represented to be Celts, and the armour and customs of the Cimbri are described by Plutarch and Strabo as very different from those of the Germans; and there is little doubt that the original invaders were joined by numerous other tribes in the course of their progress, many of whom were Teutonic. In their war with Marius, the description of their arms, and the name of their chief Bojorix, appear to designate them as Celtæ; and from the number with which they opposed Marius it is clear they could not all have come from Jutland, and if their forces had received accession from the farther north they must have been Scandinavians. But see H. Müller, 'Die Deutschen,' and Latham, Appendix to his edition of the 'Germanicus' of Tacitus.

CINCHOIDINE. [CINCHONA, ALKALOIDS OF.]

CINCHOLINE. [CINCHONA, ALKALOIDS OF.]

CINCHONA, ALKALOIDS OF. The valuable medicinal properties of *Cinchona*, or *Peruvian bark*, have long been known to be due to certain organic bases or alkaloids, but it is only within the last few years that these latter have been closely investigated, and their relations to each other pointed out. The principal ones are four in number—1, *Quinine*; 2, *Quinidine*; 3, *Cinchonine*; and 4, *Cinchonidine*. From some unimportant varieties of the bark is obtained *dricine* or *cinchovatine*. *Quinoidine* (*chinoidine, cinchoidine*), or *uncrystallisable quinine*, results from the action of heat and light on the other bases, and is procured both in the process of drying the bark and in the preparation of quinine, &c.; it is a variable mixture of the alkaloids with colouring matter and resin. *Quinicine*, isomeric with quinine, is produced by the action of a moderate heat on quinine or quinidine, and *cinchonicine* is in like manner obtained from cinchonine or cinchonidine. Finally, *quinoline* or *cincholine* (*chinoleine, leucol, leucoline*) is a base of oily consistence formed when any of the alkaloids are distilled with caustic potash or soda.

The different kinds of cinchona bark yield very variable quantities of the several alkaloids. Not only does this arise from the bark being taken from different species of the genus cinchona, but trees of the same species are greatly influenced by the soil and climate in which they grow. Usually also the bark from the thick portions contains more alkaloid than that from the smaller branches of the same tree. As a general rule, however, the article known in commerce as *pale* or *gray cinchona bark*, contains a much larger proportion of cinchonine and cinchonidine than of quinine and quindine, while the latter two predominate in the *yellow bark*. The other variety, *red bark*, mostly contains the alkaloids in about equal proportions.

A botanical description of the cinchona trees, and a lengthened consideration of the commercial varieties of the bark, will be found in CINCHONA and QUINQUINA, NAT. HIST. DIV. See also BARK, in this division.

The alkaloids do not exist in the free state in the barks, but are combined with kinic and cinchotannic acids.

1. *Quinine* ($C_{40}H_{24}N_2O_3 + n$ Aq.). Pure quinine is most conveniently prepared by adding ammonia to a solution of the neutral sulphate, collecting, washing, and drying the precipitate. It is colourless, inodorous, and extremely bitter. It fuses at about 300°, yielding when cold a yellow, translucent, friable mass, somewhat resembling common resin. Cold water dissolves 1-400th of its weight of quinine, boiling water 1-250th, cold ether 1-60th; boiling alcohol dissolves half its weight. It is also soluble in the fixed and essential oils. When an alcoholic solution is set aside to evaporate spontaneously, crystals of hydrate of quinine are obtained containing water of crystallisation. The solution of this alkaloid possesses the property of left-handed rotatory polarisation.

From the high position that quinine occupies as a medicinal agent, it has been made the subject of investigation by many eminent chemists, among whom are Pelletier and Caventou, who first isolated it in 1820, Liebig, Regnault, Laurent, Strecker, and Winckler. It is now generally admitted to be composed of—

		In 100 Parts.
Forty equivalents of carbon	240	74·07
Twenty-four equivalents of hydrogen	24	7·41
Two equivalents of nitrogen	28	8·64
Four equivalents of oxygen	32	9·88
Equivalent	324	100·00

Quinine restores the blue colour of reddened litmus, and is very soluble in all the acids, combining with them to form neutral and acid salts. The most important are the following.

Sulphate of Quinine ($C_{40}H_{24}N_2O_4,HO,SO_3 + 7$ Aq.). This salt was formerly called the *disulphate*, a name indicating that it was composed of two equivalents of base to one of acid, but the formula of quinine having since then for good theoretical reasons been doubled, the salt has necessarily now become the neutral sulphate. It is the only compound of the cinchona alkaloids that is at present recognised in medicine. It is most economically prepared from well-pulverised yellow bark by boiling in eight or ten parts of water, containing about 12 per cent of concentrated sulphuric acid, or 25 per cent. of strong hydrochloric acid; after from one to two hours ebullition the decoction is strained off, and the residue a second and a third time boiled. Quinine is now precipitated from the mixed liquors by adding excess of carbonate of soda or milk of lime; the precipitate collected on a filter, washed with cold water, submitted to strong pressure, and the residue digested in boiling alcohol yields a solution which usually deposits crystals of cinchonine on cooling; these having been separated, the liquid is neutralised with sulphuric acid and evaporated, when slightly coloured sulphate of quinine crystallises out, and may if necessary be obtained perfectly white by redissolving in alcohol, treating the solution with animal charcoal and recrystallising.

Another process of obtaining sulphate of quinine, which possesses the merit of obviating the use of alcohol, consists in boiling the bark in a solution of carbonate of soda, so as to extract its colouring and resinous matter, treating the residue with sulphuric acid, so as to obtain bisulphate of quinine, which is to be decomposed by carbonate of soda, and the precipitated quinine being redissolved in sulphuric acid and water, and treated with animal charcoal, the solution is to be evaporated to its crystallising point.

Sulphate of quinine thus obtained presents the appearance of colourless, light, bulky needles, which effloresce when exposed to the air; one part requires for solution about 740 parts of cold, or 30 of boiling water, 80 of cold alcohol of sp. gr. 0·850, and much less of boiling alcohol. When heated, sulphate of quinine becomes luminous, fuses, and on cooling has the appearance of melted wax; it afterwards reddens, begins to decompose, and when the heat is raised to ignition in the air, charcoal is obtained, and this, if the salt is pure, is eventually entirely dissipated without residue. It is one of the remarkable properties of this salt to give a blue tinge to water, producing the phenomenon of *fluorescence*. This salt is composed of—

One equivalent of sulphuric acid	40	or 9·17
One equivalent of quinine	324	„ 74·31
Eight equivalents of water	72	„ 16·52
Equivalent	436	100·00

Bisulphate of quinine ($C_{40}H_{24}N_2O_4,2SO_3,2HO,+14$ Aq.) is prepared by adding sulphuric acid to a solution of the neutral sulphate. By evaporation it is obtained in rectangular prisms. It effloresces when exposed to the air, is soluble in eleven times its weight of water at 55°, and in eight times at 72°; it is also dissolved by alcohol. At 212° it fuses in its water of crystallisation. Though neutral in composition, it is acid to litmus paper, but not sour to the taste. By the action of heat in the air it is totally decomposed and dissipated.

Nitrate of quinine ($C_{40}H_{24}N_2O_4,HO,NO_5$.) Formed by double decomposition of solutions of sulphate of quinine and nitrate of baryta, or by dissolving quinine in dilute nitric acid. When the solution of this salt is evaporated to a certain point, oleaginous drops are formed, which resemble wax in appearance when they have solidified. When they are kept some days under water, they gradually alter in appearance, and are converted into groups of regular, brilliant crystals, and it often happens that one drop becomes a single crystal. This phenomenon depends upon the circumstance that the salt when deposited hot is fused, and contains no water of crystallisation, but gradually combines with it to form crystals; the crystals are rectangular prisms with inclined bases, and do not possess any cleavage.

Hydrochlorate of quinine ($C_{40}H_{24}N_2O_4,HCl + 3Aq.$) Prepared by decomposing solution of sulphate of quinine with chloride of barium. It crystallises in silky fibres, is slightly soluble in water, and fuses below 212°.

The *bihydrochlorate* is obtained by dissolving quinine in excess of hydrochloric acid; it has a great tendency to separate into the neutral salt and free hydrochloric acid.

Chloroplatinate of quinine ($C_{40}H_{24}N_2O_4,2(HCl,PtCl_2) + 2Aq.$) Precipitated when bichloride of platinum is added to quinine dissolved in slight excess of hydrochloric acid; after standing some time, the precipitate becomes of an orange colour and crystalline. It is almost insoluble in water, and quite insoluble in alcohol. This salt may be conveniently made use of in the quantitative estimation of quinine. It is not altered by drying at a temperature of 212°; when heated to 284°, it loses two equivalents of water. Its per-centage composition is—

	By Calculation.	Gerhardt.
Carbon	31·78	31·34
Hydrogen	3·71	3·98
Nitrogen	3·71	3·40
Chlorine	28·21	28·46
Platinum	26·23	26·51
Oxygen	6·36	6·31
	100·00	100·00
Water evolved at 284°	2·37	2·37

Oxalate of quinine ($C_{40}H_{24}N_2O_4,HO,C_2O_3$). This salt is obtained by precipitating a soluble salt of quinine by a neutral oxalate; it is procured in the state of a white powder, which is but slightly soluble in water when cold, but more soluble in boiling water, and as the solution cools, the salt is deposited in silky crystals. It is very soluble in alcohol, especially when heated, and the salt crystallises as the solution cools. When excess of acid is added to the oxalate, it dissolves readily in water, and crystallises in needles of binoxalate.

Gallate of quinine. This salt precipitates in the state of a white powder, when a soluble gallate is added to a solution of a salt of quinine. It is soluble in hot water, but precipitates as the solution cools; it dissolves readily in excess of acid and in alcohol. This salt is produced when infusion of galls is added to infusion of yellow bark.

Kinate of quinine is the salt which exists naturally in the bark. It is crystalline, and may be obtained by spontaneous evaporation in mammellated white crusts, which sometimes consist of small needles that lose their transparency by exposure to the air, and assume a horny appearance. This salt is very bitter, slightly soluble in alcohol, but very soluble in water.

Iodoquinine is obtained by rubbing together quinine and iodine. It is a brown amorphous powder.

Bisulphate of iodoquinine ($C_{40}H_{24}N_2O_4, I_2, 2SO_3, 2HO + 10Aq.$), called *Herapathite*, after its discoverer, Herapath, is an exceedingly interesting body, on account of its optical properties. It is readily obtained by dissolving sulphate of quinine in concentrated acetic acid, and adding an alcoholic solution of iodine to the liquid heated to 130°. On cooling, large rectangular plates form on the surface, and may be removed by careful manipulation. By reflected light the crystals appear of a brilliant green colour, by transmitted light of a pale olive, while the whole of the light that passes through is perfectly polarised, so that a second plate placed at right angles on the first as completely prevent the passage of light as two plates of tourmaline, or Nichol's prisms.* [POLARISATION.]

2. *Quinidine* ($C_{40}H_{24}N_2O_4 + 4\,Aq.$) This alkaloid is isomeric with quinine. It is best prepared from commercial quinoidine, by digesting the latter for some time in boiling ether, filtering, evaporating the solution to dryness, digesting the residue in dilute sulphuric acid, decolourising with animal charcoal, and precipitating with ammonia. A solution of the precipitate in a mixture of alcohol and ether yields, on evaporation, large oblique rhombic prisms, which are at first quite transparent, but soon effloresce and become opaque.

Heated to 320°, quinidine loses its water of crystallisation and fuses, solidifying on cooling to a resinoid mass. It is soluble in 1500 parts of cold water, 750 of boiling water, 45 of cold absolute alcohol, 3·7 parts of hot ordinary alcohol, and 90 parts of cold ether. Its solution in alcohol rotates a ray of polarised light in a contrary direction to that produced by solution of quinine.

Quinidine combines with acids, forming a class of salts somewhat similar to the corresponding salts of quinine. The *neutral hydrochlorate* contains one equivalent less of water than the quinine salt, and the *bihydrochlorate* is far more stable than the bihydrochlorate of quinine. The acetate, tartrate, and especially the oxalate, of quinidine, are much more soluble in water than the analogous compounds of quinine.

3. *Cinchonine* ($C_{40}H_{24}N_2O_2$) is produced, as before stated, in the manufacture of sulphate of quinine; or sulphate of cinchonine may be obtained from pale or gray cinchona bark, by a process similar to that for obtaining sulphate of quinine from yellow bark, and the alkaloid separated by precipitation with ammonia. It is entirely purified from quinine by taking advantage of the fact that it is less soluble in alcohol than quinine, and that its sulphate is more soluble in water than sulphate of quinine.

Cinchonine crystallises in large, brilliant, colourless prisms. It is almost insoluble in ether, slightly so in chloroform and the fixed and essential oils, and soluble in the alkalies or their bicarbonates. Heated to 329°, it fuses and solidifies to a crystalline mass on cooling. In an atmosphere from which oxygen is excluded, it may be sublimed without decomposition. Its solution in alcohol produces dextrorotation upon a ray of polarised light.

The *salts of cinchonine* are formed, for the most part, in the same way as the salts of quinine, than which they are more soluble both in alcohol and in water. The *bisulphate* ($C_{40}H_{24}N_2O_2, 2HO, 2SO_3 + 6\,Aq.$) forms very large, beautiful rhombic octohedra. The *bihydrochlorate* treated with bromine forms *bromocinchonine* ($C_{40}H_{22}BrN_2O_2$).

4. *Cinchonidine* ($C_{40}H_{24}N_2O_2$) bears the same relation to cinchonine that quinidine does to quinine. It may be directly obtained from Maracaïbo or Bogota barks, by processes similar to those for obtaining the other alkaloids. According to M. Pasteur, the quinidine of commerce usually contains a large quantity of cinchonidine. The latter may be detected, on examination, by the transparency of its crystals compared with those of quinidine, which rapidly become opaque on exposure to the air.

Crystallised from absolute alcohol, cinchonidine occurs in very brilliant, anhydrous, rhomboidal prisms, very slightly soluble in water or ether. The alcoholic solution turns the plane of polarisation to the left. Heated to 347° the crystals melt; and at a higher temperature, if in contact with air, burn with a smoky flame, exhaling the odour of oil of bitter almonds.

The *salts of cinchonidine* are obtained with equal facility to the salts of quinine, &c. They are all more soluble in water than the quinine compounds, much more soluble in alcohol, but almost insoluble in ether. The *neutral sulphate* ($C_{40}H_{24}N_2O_2, HO, SO_3$) crystallises in stellate groups of silky needles.

* For details of the manufacture of large available crystals, see a paper by Dr. Herapath in the 'Pharmaceutical Journal,' vol. xiii. p. 378.

Methylic and ethylic derivatives of the cinchona alkaloids may be obtained by directly combining the several bases with the iodides of methyl and ethyl. They possess considerable theoretical interest.

Chlorine and bromine derivatives of cinchonine have also been described; but for these and other less important compounds, &c., of the cinchona bases, the reader is referred to Gerhardt's 'Traité de Chimie Organique,' tome iv. pp. 104-152.

The tests by which the cinchona alkaloids may be distinguished from each other are somewhat unsatisfactory, inasmuch as they do not admit of being readily applied. Liebig proposes for this purpose to take advantage of the difference of their solubility in ether; for instance, to detect the presence of cinchonine in the salts of quinine, 10 grains of the latter are agitated with a quarter of an ounce of washed ether and 20 drops of strong solution of ammonia; on standing, the mixture separates into two layers, the upper an ethereal solution of quinine, the lower an aqueous solution of sulphate of ammonia, on which floats any cinchonine that was present in the quinine salt. A test by which to detect even a trace of quinine or quinidine in a solution, consists in adding to it some recently prepared chlorine water, and then a few drops of ammonia, when a green coloration is produced if either of those alkaloids is present; by this method one grain may be detected in a gallon of water. Cinchonine and cinchonidine are not affected by this test. Quinine may be distinguished from quinidine by the opposite influence exerted by their solutions on plane-polarised light, the former being powerfully lævogyrate, the latter equally dextrogyrate. Cinchonine under the same circumstances possesses dextrorotation, cinchonidine lævorotation: this test therefore, combined with the chlorine and ammonia test, presents a means, less facile it is true than could be wished, of discriminating between these four organic bases. Dr. Herapath makes use of the difference in the optical properties of the iodosulphates of the alkaloids, as a means of distinguishing them from each other.

Quinicine and *cinchonicine* were mentioned at the commencement of this article as products of the action of heat on the cinchona alkaloids; quinine and quinidine yielding quinicine, cinchonine and cinchonidine furnishing cinchonicine. The precaution necessary to be observed in the preparation of these substances, is to fuse the alkaloids at a temperature below their decomposing point. This is accomplished by mixing with a small quantity of water and sulphuric acid, and maintaining the mixture at a temperature of about 250° for three or four hours. The change that occurs is entirely molecular, the composition of the alkaloid being unaltered.

The properties of quinicine and cinchonicine are, according to M. Pasteur, very similar to those of the bases from which they are obtained. They of course differ from each in chemical composition to the same extent that quinine and its isomers differ from cinchonine and its isomers, but otherwise they much resemble each other. Both are very soluble in alcohol, and nearly insoluble in water, unite readily with carbonic acid, expel ammonia from its salts, are precipitated from their solutions in the form of resinous liquids, and finally both turn the plane of polarisation to the right, though comparatively feebly. They are equally bitter, and as febrifuges possess equal merits.

Quinetine and *cinchonetine* are names given to the red products obtained by the action of the puce-coloured oxide of lead on boiling solutions of the acid sulphates of the alkaloids. They have not been much investigated.

Cinchovatine ($C_{40}H_{26}N_2O_8$). An alkaloid discovered by Pelletier and Corriol in *arica cinchona bark*, and called by them *aricine*. Mazzini found it in the bark of *Cinchona ovata*, and gave it the name of cinchovatine; the two are, however, identical. It is extracted in the same manner as quinine and cinchonine. Cinchovatine is insoluble in water, but dissolves in alcohol; and the solution yields large colourless inodorous prisms, which after some time have a bitter taste. It has an alkaline reaction. It melts at 370° Fahr.

The salts of cinchovatine are soluble, and crystallise very readily, especially on the cooling of saturated boiling solutions; it is soluble in ammonia, and crystallises from the solution by evaporation. The action of concentrated nitric on cinchovatine is very characteristic; it dissolves, giving an intense green colouration.

CINCHONA BARKS, *Medical Properties of.* The botanical character of some of the most important species of cinchona, as far as they were then known, as well as some of the commercial and pharmaceutical or officinal barks, have been given in NAT. HIST. DIV. Since then, much valuable information has been acquired, chiefly by Dr. Weddell, who spent two years in the cinchona forests of Bolivia and a part of Peru, and who has embodied the results of his researches in the splendid work, entitled 'Histoire Naturelle des Quinquinas,' Paris, 1849. To that book inquirers who demand full information must be referred, as well as to Schleiden, 'Pharmacognosie,' the contributions of Mr. J. E. Howard, to the 'Pharmaceutical Journal,' vols. xi., xii., xiv., and to the 'Description of Pavon's Specimens in the British Museum,' by Mr. J. E. Howard, of which part i., has just appeared; and chiefly to the elaborate investigations of the late Dr. Pereira, in vol. ii., part ii., p. 1605, 3rd ed. of his 'Elements of Materia Medica.' Lond. 1853.

It is only necessary to remark here, that Weddell divides the so-called species of cinchona of most former writers into two genera, *Chichona*, Wedd.; and *Cascarilla*, Wedd., the former comprising those species the capsule of which *dehisces from the base to the apex* (*Quin-*

quina of Endlicher, *Genera Plantar.*), and the latter, those which *dehisce from the apex to the base.* (*Cascarilla* of Endlicher). The only objection to this lies in the circumstance of the latter being liable to lead to confusion with a totally different bark, the produce of *Croton cascarilla* of the Bahamas. This strict definition excludes all species of *Exostemma, Cosmibuena,* and other plants yielding barks, useful as febrifuge medicines, but not *Cinchonas.* The practical advantage of this restriction is, that among the former only (true *cinchonas* of Weddell) are to be found, the leaves of which yield the alkaloids, *Cinchonine, Quinine, Quinidine,* and *Aricine* (?) called also *Cusco-chinchonia.* The presence or absence of these alkaloids, their relative amounts, and the facility or difficulty of separating them in a pure state, constitute the true criteria of the value of any bark—the old classification of pale, yellow, or red bark, being almost abandoned. "Dr. Weddell has proved that the young branches of several species constitute the *pale* barks of commerce, which become *yellow* or *red* in older plants, or in the older parts of the same plants." (Royle, ' Manual of Mat. Med.' 3rd ed.,'p. 482.) Besides, the manufacturer of quinine and cinchonine, uses those barks which yield him the largest returns, regardless of their appearance, names, or countries whence they come, when known. But the reckless destruction of many of the cinchona trees, diminishing the supply from the old forests, the selfishness of the monopoly company of La Paz, which aims at keeping up the price by limiting the supply, drives dealers to seek eagerly for barks which will meet the demand for the alkaloids. The barks presented for sale on their arrival in Europe, are generally recognised by the purchasers by the appearance, and to aid their judgments, the application of the methods of both qualitative and quantitative analysis, the fracture of the specimen, and the application of the microscope to transverse as well as longitudinal sections, afford considerable assistance. Even barks procured from the roots of the trees, a part formerly quite neglected, are now properly turned to account, such as that of the root or stump of *Cinchona calisaya,* var. *B. Josephiana,* Wedd.

The medical powers of a bark, as well as its price, is influenced by the circumstance of its being *coated,* that is, retaining the epidermis, or *uncoated.* The curative power of a bark is not dependent entirely on the quantity of its alkaloids, but on many of the other constituents. The activity of several barks has been estimated by Guibourt (Weddell's ' Hist. Nat. des Quinquina '), as follows ; we give the commercial names :

1. Calisaya bark.
2. Orange-yellow.
3. Pitaya.
4. Red genuine, verrucous.
5. Red genuine, non-verrucous.
6. Red Lima (fine gray. *China Haanuco*).
7. Gray Lima.
8. Hurnalies, white verrucous.

The run on quinine as a therapeutic agent causes many barks to be undervalued at the present day, if they contain cinchonine only, or but little quinine, but Delondre justly anticipates a higher appreciation of these barks when the prevailing fashion shall change, or the high price of quinine drives chemists or physicians to use cinchonine, or quinidinine. It is possible, that all the alkaloids (whether 3 or 4, for aricine is a doubtful one, and huanokinia is merely cinchonine in a state of great purity), are only different combinations of a base, *quinogen,* with different proportions of oxygen. To avoid the expense of purification, hitherto very great in Britain, various preparations have been suggested, especially *amorphous quinine ;* but the permission granted to chemists to use methylated spirit, somewhat removes the necessity for these expedients. There exists however in Paris a manufactory of an article intended expressly to adulterate sulphate of quinine.

The quinium of Labarraque, seems a very eligible preparation—also a wine of quinium.

Of comparatively recent preparations the *liquor quiniæ ammoniatus* of Bullock, is the most quickly active—which renders it invaluable in influenza and other diseases attended with great debility.

In estimating the action of cinchona bark on the human system, it deserves to be borne in mind that the resin gives it a stimulating power, the kinate of cinchonine or quinine a tonic power, and the tannin an astringent property. By the first of these it approaches the balsamic stimulants and tonics, by the second the mineral tonics, while by the third it approximates to rhatany and catechu. Notwithstanding these resemblances, its action in the aggregate is strictly peculiar, so much so that all attempts to procure a substitute for it, whether among exotic or indigenous plants, have been attended with little success. It appears to act directly upon the nerves, particularly those of organic life, but its influence is speedily extended to the vascular and muscular system.

A moderate dose of cinchona taken into the stomach, and repeated in three or four hours, is followed by increased force and frequency of the pulse, greater firmness and constriction of the arterial tunics, augmented heat of surface, a flow of perspiration, and a universally improved tone of the system. The digestive and assimilating processes are greatly expedited, and the individual feels himself fit for exertions from which he would have shrunk before. This stimulating action does not cause vertigo or unpleasant derangement of the function

of the brain. The secretions of all the mucous membranes, however, are diminished, and in most persons the bowels become constipated, but occasionally an opposite state, or diarrhœa, is induced.

It is justly considered the most valuable tonic and febrifugal medicine we possess. The forms of administration are numerous. Powder is objectionable from its bulk, disagreeable taste, and difficult digestibility, owing to the quantity of woody fibre which it contains. Infusion is a good form, but does not possess all the virtues of the bark, which, however, are all taken up by the tincture : the spirit present in this last form is often an obstacle to its being given in a sufficient dose ; it is therefore generally added to the infusion or decoction. Decoction, if the process be long continued, dissipates the volatile or aromatic portion, and diminishes its powers. The tincture is often formed by the addition of other substances, as in the compound tincture of bark, which is a valuable adjunct to other remedial means in weak subjects. Acids or ammonia are sometimes given along with it, according to the nature of the complaint.

The ease with which a small dose can be taken of the sulphates of quinine or cinchonine leads to the substitution of these preparations for that of the bark itself ; and in many cases they are more eligible, but in others the want of the resinous and astringent principles renders these less proper. Perhaps the best and most convenient form, as it can be administered in a variety of ways, is one in which the bark is separated into its constituent parts, the woody fibre removed, and the other principles again united : this is called the aromatic kinate of kinia. It keeps well in all climates, is not bulky, and retains its efficacy for several years. For long voyages it is the best form into which bark can be put.

It is proper to direct attention to the great prophylactic power of cinchona, and its preparations, in warding off the fevers of tropical countries, especially in the exploring expeditions to the rivers of Africa. Very large doses of quinine administered to the crew, daily, of the vessels, as soon as they approach the miasmatic districts, has been found effectually to preserve them from the attack of ague and other fevers. It is requisite to continue to take the quinine, even after returning to Europe ; for in some instances, where it has been taken continuously for six months after arrival in England, on its discontinuance, fever has manifested itself.

CINCHONETINE. [Cinchona, Alkaloids of.]

CINCHONICINE. [Cinchona, Alkaloids of.]

CINCHONIDINE. [Cinchona, Alkaloids of.]

CINCHONINE. [Cinchona, Alkaloids of.]

CINCHOVATINE. [Cinchona, Alkaloids of.]

CINNABAR. [Mercury, *Bisulphide of.*]

CINNAMATES. [Cinnamyl, *Cinnamic* Acid.]

CINNAMEIN ($C_{36}H_{16}O_4$) is found in balsam of Peru. It contains cinnamic acid united to an ether.

CINNAMENE ($C_{16}H_8$) is formed when cinnamic acid is distilled with baryta.

CINNANIC ACID. [Cinnamyl.]

CINNAMIC GROUP. A group of organic compounds, belonging to the Benzoic Series. The following are the names and formulæ of the chief members of this group :—

Hydride of cinnamyl	$\left.\begin{matrix}C_{18}H_7O_2\\H\end{matrix}\right\}$
Anhydrous cinnamic acid	$\left.\begin{matrix}C_{18}H_7O_2\\C_{18}H_7O_2\end{matrix}\right\}O_2$
Hydrated cinnamic acid	$\left.\begin{matrix}C_{18}H_7O_2\\H\end{matrix}\right\}O_2$
Chloride of cinnamyl	$\left.\begin{matrix}C_{18}H_7O_2\\Cl\end{matrix}\right\}$
Cinnamide	$N\left\{\begin{matrix}C_{18}H_7O_2\\H\\H\end{matrix}\right.$
Cinnamene	$\left.\begin{matrix}C_{16}H_7\\H\end{matrix}\right\}$
Styrone	$\left.\begin{matrix}C_{18}H_9\\H\end{matrix}\right\}O_2$
Cinnhydramide, or hydride of nitrocinnamyl	$C_{54}H_{24}N_2$
Cinnanilide	$N\left\{\begin{matrix}C_{18}H_7O_2\\C_{12}H_5\\H\end{matrix}\right.$
Cinnitraniside.	$N\left\{\begin{matrix}C_{18}H_7O_2\\C_{14}H_6(NO_4)O_2\\H\end{matrix}\right.$
Thiocinnole, or hydride of sulphocinnamyl	$\left.\begin{matrix}C_{18}H_7\\H\end{matrix}\right\}S_2$

A description of some of these bodies will be found under their respective names. For that of the others the reader is referred to Gerhard's ' Traité de Chimie,' tome iii. 373.

CINNAMIDE. [Cinnamic Group.]

CINNAMON and CASSIA. There are many contradictory statements about cinnamon and cassia. In the following account we chiefly follow Fr. Ludwig Nees von Esenbeck, who has paid great attention to the subject. According to him the finest or Ceylon cinnamon is procured from the three-year old branches of the *Cinnamomum Zeylanicum* (Blume), which is found native in the island of Ceylon only ; the cultivation, however, has been extended to Java,

and to South America. Though found in various parts of the island, it is most abundant in the south-west part, near Colombo, and yields the best cinnamon when growing in a sandy quartz soil. The time for stripping off the bark is from May to October. The bark, after being removed from the branches, is tied up in bundles for twenty-four hours, during which time a sort of fermentation takes place, which greatly facilitates the separation of the outer part of the bark from the cuticle and epidermis, which is very carefully scraped off the Ceylon cinnamon. It is then rolled up into quills, or pipes, about three feet in length; the thinner or smaller quill being surrounded by larger ones; a mark which always distinguishes cinnamon from cassia. It is then conveyed to Colombo, where it is sorted by government inspectors into three kinds, of which the two finest alone were allowed to be exported to Europe, while the third, or inferior kind, was reserved to be distilled, along with the broken pieces of the other two, for the purpose of obtaining the oil of cinnamon. The select cinnamon is formed into bales of about 92½ lbs. weight, containing some pepper or coffee, and wrapped in double cloths made of hemp, and not, as stated by some writers, of the cocoa-tree.

This fine cinnamon occurs in pieces about forty inches in length, generally containing from six to eight rolls or quills in each, one within the other, of the thickness of vellum paper, of a dull golden yellow colour, smooth on both outer and inner surface. It is very fragrant, agreeably aromatic, taste pleasant, warm, aromatic, slightly astringent. Analysed by Vauquelin, it yielded volatile oil, tannin in large quantity, an azotised colouring matter, resin, a peculiar acid, mucilage, and feculum.

The root of the cinnamon-tree yields a kind of camphor, and the leaves yield an oil which resembles oil of cloves, which it is often used to adulterate. This is quite distinct from the oil of cinnamon obtained from the bark. The ripe berries yield by decoction a solid volatile oil, similar to the oil of junipers. Cassia, according to Marshall and others, is the bark of the old branches and trunk of the *Cinnamomum Zeylanicum* already mentioned, while others assert that is the bark of an entirely different species, namely, of the *Cinnamomum Cassia* (Nees Fratres, et Blume), a native of China, but cultivated in Java. This last view is much the most probable: for not only is no cassia exported from Ceylon (except the rejected, or third sort of cinnamon, which is introduced into England incorrectly under that name), but almost all the cassia which reaches Europe comes from Canton, hence called on the Continent Chinese cinnamon. Reagents produce very different effects both on the infusion and oil of these two barks, which is a rational ground for believing them to be obtained from different species. Tincture of iodine renders decoction of cassia blue, but not cinnamon.

Cassia is easily distinguished from cinnamon. The bales in which it arrives are much smaller, containing only from two to four pounds, bound together by portions of the bark of a tree. The quills are thicker, rolled once or twice only, and never contain thinner pieces within; the diameter of the bark is much thicker than that of cinnamon, and harder, the outer rind less carefully removed (large patches of the cuticle and epidermis often remaining upon it), the colour deeper, of a brownish fawn colour (that raised in Guiana is yellowish), with the odour of cinnamon, but fainter, and less grateful, the taste more acridly aromatic, pungent, less sweet, at the same time more powerfully astringent, yet mucilaginous.

Cassia is often substituted for cinnamon, and it is also frequently adulterated with cassia lignea (which is the bark of a degenerate variety of the *Cinnamomum Zeylanicum* (Blume) growing in Malabar, Penang, and Silhet), with the bark of *Cinnamomum Culitlawan*, and with portions which by distillation have been deprived of their volatile oil. This yields the bitter cinnamon, but what is sold in the shops under the name of culitlawan bark, is, according to Blume, a mixture of several Indian barks, especially those of *Cinnamomum Sintoc javanicum* and *C. xanthoneurum*. The old "folia Malabathri" is a mixture of *C. nitidum* and other species.

Oil of cinnamon is obtained chiefly from the fragments which fall from the quills during the inspection and sorting at Colombo. These fragments are coarsely powdered, and after being immersed for forty-eight hours in sea-water, are distilled, when a milky fluid comes over, which separates into two parts, a light oil which floats, and a heavy one which sinks in the water. Eighty pounds weight of cinnamon yield about two ounces and a half of light oil, and five ounces and a half of heavy oil. About 100 gallons of oil of cinnamon are annually obtained at Colombo. As the oil which is met with in commerce is a mixture of these two, the specific gravity is variable, 1·035 to 1·090. In time a spontaneous separation takes place, and there are formed beautiful transparent crystals of a *stearopten* or cinnamon-camphor. Sometimes benzoic acid is formed. Oil of cassia is also obtained by distillation; at first it is whiter than oil of cinnamon, afterwards it becomes yellow, but never of such a fiery yellow as cinnamon-oil. The odour is agreeable, but not so delicate and cinnamon-like: taste, acrid, burning, but different from cinnamon. Specific gravity 1·0608: it reddens litmus paper. At a low temperature crystals show themselves, which disappear with an increase of heat. Some consider these a camphor, others benzoic acid. Benzoic acid unquestionably exists in this oil. Oil of cinnamon is adulterated with oil of cassia, with the oil of cassia-buds, with the oil of the *Cerasus lauro-cerasus*, or cherry-laurel, and it is also said, with oil of bitter almonds, an exceedingly dangerous intermixture.

Cinnamon is an extremely valuable aromatic stimulant, and influences both the nervous and vascular system, especially of the stomach and intestines. It is of great utility in weakness of the digestive powers, unaccompanied with inflammatory action of the stomach; while in fluxes from atony of the intestines, its astringent properties, due to the tannin, render it a very useful medicine. It is the best of all condiments to be taken with food, particularly vegetables, during the prevalence or tendency to cholera. Even in fevers of an asthenic type, it has been advantageously joined with bark, and the compound cinnamon-powder is added to many medicines. Oil of cinnamon, given on sugar, is useful in cramps and other spasmodic diseases. Cassia has the same properties in less degree. Clove cinnamon, stated by some to be the produce of *Persea caryophyllacea* (Martius), is most probably the bark of the *Eugenia caryophyllata*, or of *Dicypellium caryophyllatium*, a native of Brazil. It has very little volatile oil.

CINNAMON, OIL OF. [CINNAMYL.]

CINNAMYL ($C_{18}H_7O_2$), the hypothetical radical essence of cinnamon.

Hydride of cinnamyl ($C_{18}H_7O_2+H$) is the purified essence or oil of cinnamon. It is a fragrant oil, and forms with nitric acid a crystalline compound ($C_{18}H_8O_2+NO_5,HO$), which, when mixed with water, is resolved into its original constituents, hydride of cinnamyl and nitric acid. When it is exposed to the air it absorbs oxygen, and becomes converted into *cinnamic acid* ($C_{18}H_7O_3+HO$). This acid is also easily obtained by dissolving oil of balsam of Peru in a solution of potash in alcohol, evaporating to dryness, dissolving in hot water, and adding to the cinnamate of potash then formed hydrochloric acid. With bases it forms *cinnamates*. *Nitric* acid converts it into hydride of benzoyl. When added to cold nitric acid, it is converted into *nitro-cinnamic acid*. The salts of this acid detonate when heated. When cinnamic acid is treated with fuming sulphuric acid, *sulpho-cinnamic acid* is formed. [BALSAMS.]

CINNANILIDE. [CINNAMIC GROUP.]

CINNHYDRAMIDE. [CINNAMIC GROUP.]

CINNITRANISIDE. [CINNAMIC GROUP.]

CINQUE-CENTO STYLE. [RENAISSANCE.]

CINQUE PORTS. It has been a subject of controversy, whether this association of the maritime towns on that part of the English coast which approaches nearest to the Continent existed in any shape before the Norman conquest of England. Some writers have supposed that it originated with the Romans, and that the five stations of Regulbium or Reculver, Rutupiæ or Richborough, Dover, Lymne, and Anderida, probably the present Eastbourne, were selected by them as favourable points for protecting the southern coast, and no doubt as being also good ports. When the altered state of the shore rendered some of them no longer available as ports, the privileges, whatever they were, were transferred to other ports more favourably situated; and thus, as early as Edward the Confessor, only Dover continued, and the places of the other four were supplied by Sandwich, Hythe, Romney, and Hastings. Still of this there is no positive proof. The Domesday Survey only mentions three, Sandwich, Dover, and Romney; but Mr. Jeake, the town-clerk of Rye, collected the charters relating to the Cinque Ports, which were published in 1728, under the title of 'Magna et Antiqua Charta Quinque Portuum,' &c. In these the first charter of Edward I. confirms the peculiar privileges and liberties of the towns granted by his predecessors, of whom the first named is Edward the Confessor. From the Domesday Survey it appears that the three ports mentioned, on consideration of certain services to be performed by their shipping at sea, &c., were exonerated from such contributions and burdens as other towns were generally charged with; and these, it is reasonably thought, might have been enfranchised by the Confessor at one and the same time.

Though some part of the municipal constitutions of the individual ports may be anterior to the Norman invasion, yet the organisation of the general body, as it has existed in later times, is plainly traceable to the policy of the Conqueror, in securing, by every means, his communications with the Continent. These ports and their members occupy exactly the tract of sea-coast of which, after the victory of Hastings, he showed most eagerness to possess himself, by sweeping along it with his army before he directed his march towards London; and the surrender into his hands of the castle of Dover, which is the centre of the Cinque Ports' jurisdiction, was one of the stipulations introduced into the famous oath which, in Edward's lifetime, the duke had extorted from Harold. To enable his government to wield the resources of this maritime district with the greater vigour and promptitude, he severed it wholly from the civil and military administrations of the counties of Kent and Sussex, erecting it into a kind of palatine jurisdiction, under a *gardien*, or Warden, who had the seat of his administration at the castle of Dover, and exercised over the whole district the combined civil, military, and naval authority; uniting in his own hands all the various functions which, to use the terms most intelligible to modern readers, we may describe as those of a sheriff of a county at large, a custos rotulorum, a lord lieutenant, and an admiral of the coast.

To the five ports of the Conqueror's time were added, before the reign of Henry III., with equal privileges, what were called the *ancient*

towns of Winchelsea and Rye, lying on the Sussex coast, between Hastings and Romney. To each of these seven municipal towns, except Winchelsea, were attached one or more subordinate ports or towns, denominated *members* of the principal port. The following is a list of the Cinque Ports, and the two ancient towns, with their dependent members, as they stood at the commencement of the 19th century :—

Ports.	Detached Members.
Hastings.	1. Corporate town of Pevensey; distant 12 miles from Hastings. 2. Corporate town of Seaford; distant 22 miles. 3. Part of Bexhill parish, in Pevensey Marsh; distant 8 miles. 4. Small part of St. Leonard's parish, near Winchelsea; distant 9 miles. 5. Beaksbourne parish, near Canterbury; distant 48 miles. 6. Vill of Grange, or Grench, near Rochester; distant 50 miles.
Winchelsea.	
Rye.	1. Corporate town of Tenterden; distant 10 miles.
Romney.	1. Corporate town of Lydd; distant 3 miles. 2. Denge-marsh; distant 5 miles. 3. Orlestone; distant 10 miles.
Hythe.	
Dover.	1. Corporate town of Folkestone; distant 7 miles. 2. Corporate town of Faversham; distant 25 miles. 3. Parish of St. John, containing the town of Margate; distant 21 miles. 4. Parish of St. Peter; distant 19 miles. 5. Parish of Birchington; distant 20 miles. 6. Parish of Ringwould; distant 5 miles.
Sandwich.	1. Corporate town of Fordwich; distant 10 miles. 2. Corporate town of Deal: distant 6 miles. 3. Vill of Ramsgate, including the town of that name; distant 4 miles. 4. Vill of Sarr; distant 5 miles. 5. Parish of Walmer; distant 8 miles. 6. Parish of Brightlingsea in Essex; distant 40 miles.

It is probable that in very early times all the members were in some measure dependent on, or subject to, their respective ports; but in latter times there was no connexion between any port and such of its members as have been incorporated, beyond that which exists among all the ports, excepting only the connexion between Sandwich and Deal. Each incorporated member had within its liberty the same independent jurisdiction and municipal functions as the port itself. The unincorporated members remained under the municipal jurisdiction of their respective ports; they were within the jurisdiction of the criminal and civil courts, and of the magistrates and coroners of those ports; they were summoned on the juries, and contributed to the rates, in the nature of county rates, imposed by the justices of those ports. Yet none of the municipal franchises could be acquired in these members, nor had they any share in electing any of the officers of their respective ports; residence within them was not considered, for any corporate purpose, as residence within the port. The relation between Sandwich and Deal was peculiar. Deal was incorporated by William III., before which time it was exclusively under the jurisdiction of Sandwich. William's charter gave Deal a jurisdiction of its own; but as it did not interfere with the original jurisdiction of Sandwich, the latter retained a concurrent jurisdiction in Deal.

The internal constitution of each port, as well as the Norman denominations of *jurats* and *barons*, which, in lieu of aldermen and freemen, have constantly prevailed in them all since the time of William I., concur to show the solidity of his plan for rendering this maritime line one of the grand outworks of the Conquest. The earliest members of the municipal bodies established under these foreign denominations, at a time when the English municipalities in general were subjected to the most rigorous enslavement, were doubtless trading settlers from William's Continental dominions: and the term *barons*, as applied to the Cinque Ports' representatives, which in the later periods of English parliamentary history has usually been considered as simply synonymous with *burgesses*, did, before the several elements of the Commons' House coalesced into one homogeneous body, imply a political as well as a municipal superiority.

Until the time of Henry VII. the crown appears to have had no permanent navy: the Cinque Ports constantly furnished nearly all the shipping required for the purposes of the state, and their assistance to the king's ships continued long after that time. When ships were wanted, the king issued his summons to the Ports to provide their quota. In the time of Edward I. the number they were bound to provide was fifty-seven, fully equipped, at their own cost: the period of gratuitous service was limited to fifteen days. The summons in Edward III.'s time seems to have apportioned the ships among the ports and their members: some of the members had to provide one ship; and in some cases two members had to provide one between them. It is in consideration for these services that, in the preambles of the existing charters, the peculiar privileges and exemptions of the ports are stated to have been granted. These towns, owing to various causes, have long since lost their ancient importance. The physical changes that have taken place in the course of ages upon the coast-line may have had some effect. Rye and Romney, once standing on the shore, are now at some distance from it. Sandwich is only accessible for small vessels; and Folkestone, one of the members of Dover, has only recently had its importance restored by becoming a station and port in connection with the South Eastern Railway. But the complete organisation of a permanent navy involved the extinction of that description of service on the part of these ports, in consideration of which their privileges were avowedly granted; and their inferiority as ports, and their distance from all the great seats of English manufactures, sufficiently account for their present commercial insignificance.

Each of the five original ports returned two *barons* to parliament, as early as the 18th of Edward I.; Seaford, a corporate member of Hastings, sent as early as the 26th of the same reign; and the two ancient towns, Rye and Winchelsea, sent as early as the 42nd of Edward III. The peculiar nature of the relation between the Cinque Ports and the crown must have given the latter, from the commencement, a very powerful influence in their internal transactions; and, in later times, when the parliamentary relations of the municipal towns came to be the grand object of solicitude to the royal prerogative, these municipalities imbibed an ample share of the prevalent municipal as well as political corruption. In the 20th of Charles II. the first open blow was struck by the crown at the liberties of the Ports in general, in the provision of Charles's charter of that year, by which the elections of all their recorders and common clerks were made subject to the royal approbation. Subsequently, in 1685, all the general charters of the Ports, and most of the particular charters of each individual town, were, by the king's special command, delivered up to Colonel Strode, then constable of Dover Castle, and were never afterwards recovered.

The lord-warden is the general returning officer for all the ports, the writs at every general election being directed to him in the same manner as to sheriffs of counties, whereupon he issues his precept for the election to the proper officer of each port. Before the Revolution of 1688 the lord-wardens assumed the power and the right of nominating one, and sometimes both, of the members for each of the port-towns having parliamentary representation; but this practice was terminated by an Act passed in the first year after the Revolution, entitled 'An Act to declare the Right and Freedom of Election of Members to serve in Parliament for the Cinque Ports.' The necessity for such an enactment proves how firmly the practice must have been established; but although this statute had the effect of taking away the privilege from the lord-warden, the result was, that the Treasury influence was enabled to return both members. The admittance of persons to the freedom of the ports became more and more restricted, till in most cases the right was almost solely vested in the corporations, and the corporations became family parties; corruption and bribery were established customs; and the freedom of a Cinque Port town was always considered as entitling its possessor to a provision of some sort. Repeated attempts were made, by trials in courts of law, and by election petitions to the House of Commons, to effect a reform in the representation; but though successful in one or two individual cases, there was no lasting improvement until the whole was effectively altered by the Reform Bill in 1832, and still further by the Municipal Reform Bill of 1835.

For all purposes except one or two, each corporate town of the ports possessed all the jurisdiction and arrangements of a separate county, and the circuit judges held no assizes within their liberties; each town, too, had its distinct rate in the nature and for the purposes of a county rate, and its civil court of record; and most of the duties analogous to those of a sheriff of a county at large were exercised separately and exclusively in each of the port towns. According to the originally uniform Norman constitution of the ports, the number of jurats in each corporation ought always to have been twelve, besides the presiding officer, each of whom was, *ex officio*, a judge both of the civil and criminal court. The mayor or bailiff, and two other jurats, constituted a quorum. It became, however, the practice in most of these towns to keep the number of jurats as low as possible, scarcely ever exceeding four or five. From the body of jurats in each port, or corporate member, the mayor or bailiff was elected, who frequently continued to hold the office for life or for a long period; and when the continuous holding was forbidden by the 9 Anne, cap. 20, the Act was evaded by two persons agreeing to hold the office in alternate years, or by appointing some mere dependent.

The jurisdiction of the Cinque Ports collectively extends along the coast, continuously, from Birchington, which is west of Margate, to Seaford in Sussex. But several of the corporate members are quite inland. Tenterden, in the centre of a rich agricultural district, has not even a river near it. Many of the unincorporated members are not only inland, but situated at great distances from their respective ports, some as far as forty to fifty miles. All the unincorporated members being exclusively under the jurisdiction of their own ports, each of those members was obliged to have recourse to the justices and coroner of its own port. Great inconvenience was experienced from this state of things, especially in those towns where the distance from the principal port was considerable.

The Parliamentary Reform Act of 1832 worked a considerable revolution in the political relations of the Cinque Ports. From three of the towns, Seaford, Winchelsea, and Romney, the right of returning members of parliament was wholly withdrawn; Rye and Hythe were

reduced to one each; and Hastings, Dover, and Sandwich, still return two each. In the several constituencies of these five remaining parliamentary boroughs, besides the important change effected by the introduction of the household franchise, the new regulation of the parliamentary boundaries made very material alterations. Hastings and Dover have experienced the least change in this latter respect. In the case of Hastings, the two nearest of the detached members have simply been added to the "home liberty" of the port itself, as before existing; and in that of Dover, the most populous part of one of the adjoining parishes has been added to the immediate liberty of the port. But in forming the new parliamentary borough of Rye, not only have the two "ancient towns" of Rye and Winchelsea been thrown together, but six surrounding agricultural parishes are also included within their common boundary. In like manner, Folkestone, a corporate member of Dover, is now joined with Hythe, and five adjacent agricultural parishes, in composing the parliamentary borough of Hythe; and to the ancient home liberty of Sandwich are added, for parliamentary purposes, the corporate town and parish of Deal, and the contiguous parish of Walmer.

The Municipal Reform Act has operated yet more decisively to break up the ancient organisation of the ports, and assimilate their internal arrangements to those of the improved English municipalities at large. The details will be found under the heads of the respective towns in the GEOGRAPHICAL DIVISION.

The jurisdiction in capital cases, formerly possessed by the ports, is abolished by the Act in common with all similar jurisdictions; and as regards the limits of the authority of the courts and magistrates of the ports, provision is made by section 134 of the same Act.

Anciently there were several courts, exercising a general jurisdiction over all the ports and members. The Court of Shepway was the supreme court of the Cinque Ports. The lord warden presided in it, assisted by the mayors and bailiffs and a certain number of jurats summoned from each corporate town. The following offences seem to have been cognisable within the ports' jurisdiction by this court only: treason, sedition, counterfeiting the king's coin or seal, and concealing treasure found. It was also a court of appeal from the judgments of the several local courts. This court has been so long obsolete that even the site of it is now unknown, except that it was most probably somewhere in that central part of the ports' jurisdiction about which lies the division of the county of Kent, still denominated "the lathe of Shepway." Two other ancient courts are still occasionally held, the Court of Brotherhood and the Court of Guestling. The name of the former seems to indicate its purpose to have been the regulating of the affairs of the fraternity or association of the ports in general. The latter court seems to have been only a modification of the former, practised on certain occasions. The Court of Brotherhood is composed of the mayors of the five ports and two ancient towns and a certain number of jurats from each of them. The Court of Guestling consists of the same persons, with the addition of the mayors and bailiffs of all the corporate members, and a certain number of jurats from each of them. It is thought that the bodies forming this addition may originally have been merely *invited* by the Court of Brotherhood to give their assistance, and that hence the assembly may have received the name of Guestling. The chairman of the court is called the speaker, and the office is filled in rotation by the mayors of the five ports and two towns, each for one year. The speaker sends a letter every year to each of the corporations composing the two several courts, asking their opinion as to the expediency of holding either of them; and if a majority answer in the affirmative, the speaker convenes the court. One of the more important functions of the Court of Brotherhood anciently was the appointment of the two bailiffs whom the Cinque Ports had the privilege of sending to superintend their affairs at Yarmouth in Norfolk, and the examination of the conduct of those officers. The securing of certain facilities for carrying on the fishery during the herring season, granted to them by charter, and enforced by successive royal ordinances, seems to have been the main object of the residence of these officers of the ports at Yarmouth, where also, together with the bailiff of that town, they had the keeping of the peace and the care of the prison during the fair, with the power of determining all disputes and complaints. As late as the reign of Elizabeth we find traces of the contentions which were constantly arising between the bailiff of Yarmouth and the bailiff of the Ports residing there. In the Court of Brotherhood, also, the arrangements and regulations were made as to the apportioning of the service of ships to the crown. In these general courts, too, assessments were made upon all the ports and members for defraying the general expenses of the association; and in them all disputes between any of the ports, towns, or members were settled, and complaints of misconduct in any of their officers were inquired into and redressed. The necessity for proceedings of this kind no longer exists; and although these courts have been occasionally held of late years, such holding seems to have been mere matter of form, excepting only the Courts of Brotherhood and Guestling held before each coronation, at which the arrangements have been made respecting the privilege of the *barons* of the ports to hold the canopy over the king's head on that occasion; another mark of the pre-eminence among the municipalities of England given to these towns by the princes of the Norman line.

It remains to notice more particularly the nature of the Lord Warden's jurisdiction as now exercised. One important branch of a sheriff's jurisdiction is exercised by him over all the ports and members—namely, the execution of writs and the custody of debtors. All writs out of the superior courts are directed to the Constable of Dover Castle, who is always the lord warden, upon which his warrant is made out, directed to and executed by an officer called the *bodar*. This officer, by a curious anomaly, has also the execution of writs out of the distant civil court at Hastings; and the necessity of having recourse to him has been a source of inconvenience and dissatisfaction to the latter town. The clerk of Dover Castle acts as under-sheriff. The constable's jail for debtors is within Dover Castle; and by Act 54 Geo. III. c. 97, their maintenance is provided for by an annual contribution of 300*l*., to be levied on the ports and members in proportions fixed by the Act. The lord warden has power to diminish this sum if he think it more than sufficient, and to increase it again. The money is paid over to the registrar of the Cinque Ports, who, at the time of the framing of the report of the late municipal commissioners, was the same person as the clerk of Dover Castle.

The admiralty jurisdiction of the Cinque Ports, attached to the office of lord warden, is expressly reserved in that clause of the Municipal Reform Act which abolishes chartered admiralty jurisdictions in general. A branch of this jurisdiction appears in the court of Lodemanage, so called from the old English word *lodeman*, a *lead*-man or steerer, which is held for the licensing and regulating of pilots, by the lord warden and a number of commissioners, of whom the mayors of Dover and Sandwich are officially two. The lord warden seems anciently to have held a court of chancery in one of the churches at Dover, but it has long been obsolete.

(Jeake's *Charters of the Cinque Ports;* Holloway's *History of Rye.*)

CIPHER is derived from the Arabic Sifr, which originally signifies "empty, devoid of," and is used as a substitute to denote the figure 0. The peculiar meaning of this symbol, and the important consequences of its use, gave to the Arabic arithmetic the name of *ciphering*, which it retains to this day.

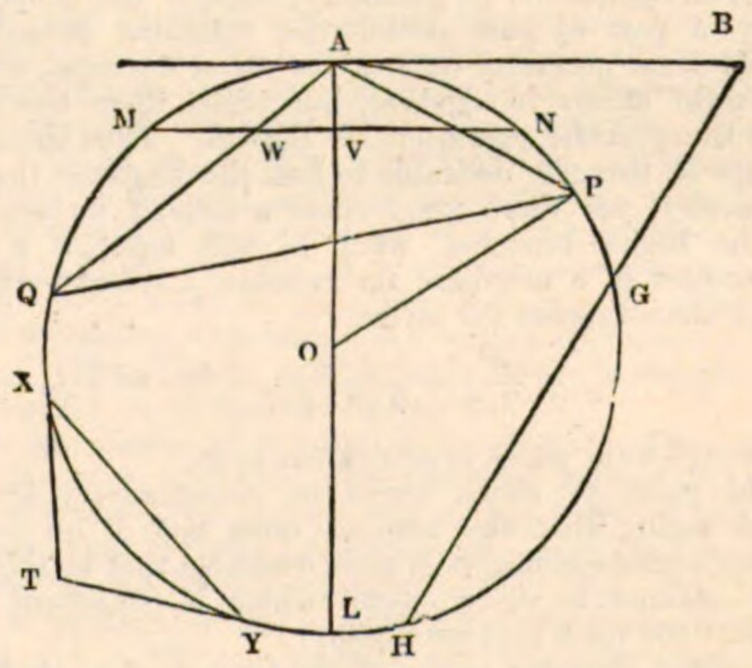
CIRCE, one of the group of small planets revolving between Mars and Jupiter. [ASTEROIDS.]

CIRCENSIAN GAMES. [CIRCUS.]

CIRCINUS, the Compasses, a constellation of Lacaille, below Centaurus, and not very far from the South Pole. Its principal star is α, of the fourth magnitude, No. 1225, in the Catalogue of Lacaille, and 4835 in that of the British Association.

CIRCLE (*circulus*, a little circle, from *circus*, a ring), the figure formed by a point which revolves in a plane surface, and always preserves the same distance from a given point. The points of view under which this word might be considered are with reference, first, to its properties as a figure of geometry; second, to the history of the researches which were made for centuries, in order to discover the exact ratio of the circumference to the diameter; third, the effect of the properties of the circle upon several branches of mathematics. For the second, we refer to the word QUADRATURE; we shall give a few of the first, and a sketch of the third.

The word circle is sometimes used to denote the *circumference* or boundary line, sometimes the inclosed figure or area. Frequently a point *in* a circle means a point on the circumference; but a point *within* a circle always means a point in the interior. The *centre* is the point from which all the *radii* drawn to the curve are equal; a diameter is a double radius.



Draw a circle with a centre O, and let O A be any radius. Draw A B perpendicular to the radius, and M N also perpendicular to the radius. Take any points, P and Q, &c. Then among the most essential properties of the circle are the following:—

1. A B is a tangent to the circle.
2. M N is bisected (halved) by V.
3. The square on V N is equal to the rectangle (oblong), whose sides are A V and V L.
4. If any two chords (M N and A Q) cut in W, the rectangle, whose sides are M W and W N, is equal to that whose sides are Q W and W A.
5. The square on A B is equal to the rectangle whose sides are B G

and B H, if the line B H be any line drawn through B, cutting the circle.

6. If Q move round the circle, and A and P remain fixed, the angle (opening) A Q P preserves the same magnitude throughout, namely, half of the angle A O P, and equal to the angle B A P.

These properties, with several others which are *visibly* true, are in the third book of Euclid. We name one or two others, the verification of which will be a test of correctness in drawing for those who know how to use the compass and ruler.

7. From any point T exterior to a circle, two tangents T X and T Y (of equal lengths) can be drawn. Let T be called the *pole* of X Y. Then if any number of poles be taken on the same straight line (which call the polar line), all their chords pass through the same point; which last point is interior to the circle if the polar line be altogether exterior; and exterior, if the polar line cut the circle.

8. If any hexagon, having no opposite sides parallel, be drawn in a circle, the three points of intersection made by lengthening the opposite sides must be in one straight line.

To find the circumference of a circle (with more than sufficient nearness for practical purposes), take the 113th part of 355 times the diameter (A L) or 3·14159 times the diameter. To find the area in *square* units, multiply the number of units in O A by itself, and take the 113th part of 355 times the result (or multiply by 3·14159). Given the arc A P, and the radius O A, to determine the angle A O P. [ANGLE.] And the same for the inverse question. To find the area of the sector A O P in square units, take half the product of the units in the radius and the arc A P. These are the principal questions which can be solved by a person unacquainted with trigonometry.

The influence of the properties of the circle upon abstract mathematical analysis has been so great, that an attempt to describe the manner in which the means of expression derived from this figure have been used would fill a volume. We can only here give such a description as will help the beginner in trigonometry to extend his notions of the symbols he uses. Originally the sine, cosine, &c. [TRIGONOMETRY], meant certain lines drawn in a circle, with reference to a given angle at the centre. Each angle therefore had a sine, &c. for every different length which the radius might be conceived to have. But this introducing an unnecessary complexity into formulæ, it was thought sufficient always to suppose the radius a unit, which was however always expressed. Thus in the first stage of the science we have this theorem: "The sine of 30° is half the radius," which in course of time took this form, "The radius being 1, sin. 30° is $\frac{1}{2}$." This method amounted to defining the sine, &c. to be, not the lines which they originally stood for, but the numerical ratios of these lines to the radius. Thus the sine, cosine, &c. became abstract numbers. The next step was to make the angle itself an abstract number, in the manner which [ANGLE] we have called the *theoretical* or *arcual* method of measurement; that is, instead of measuring the angle by an arbitrarily chosen angle, such as a degree or a minute, the numerical ratio of the arc to the radius became the measure of the angle. One extension more completed the subject. Angles of more than four right angles were admitted, conceived to be made by the revolution of a point, which was considered as having made more revolutions than one. Thus any number represented some angle, and had its sine, cosine, &c. And the angles themselves being abstract numbers, and also their sines, &c., it followed that all the propositions of what was trigonometry, an application of geometry, became the propositions of trigonometry, a part of pure arithmetic; retaining indeed the old names derived from geometry (names are never changed, witness the use of the term *square* in algebra), but based upon the notion of number, and the symbolic operations of algebra. Thus though it will always perhaps be thought desirable to lead the beginner through the gate of geometry, yet there must come a time, if he continue his studies to the higher branches, when he will consider a sine as a number, a function of a number; for instance, x being a number, the sine of the number x means the series

$$x - \frac{x^3}{2.3} + \frac{x^5}{2.3.4.5} - \text{\&c. } ad\ inf.,$$

or any algebraical form which is equivalent to it.

This is the point to which works on trigonometry are rapidly tending; and seeing that the student must end, if he pursue his course, in such considerations, it is most desirable that he should begin in the same manner, to every extent which is consistent with not forcing abstractions upon him too rapidly.

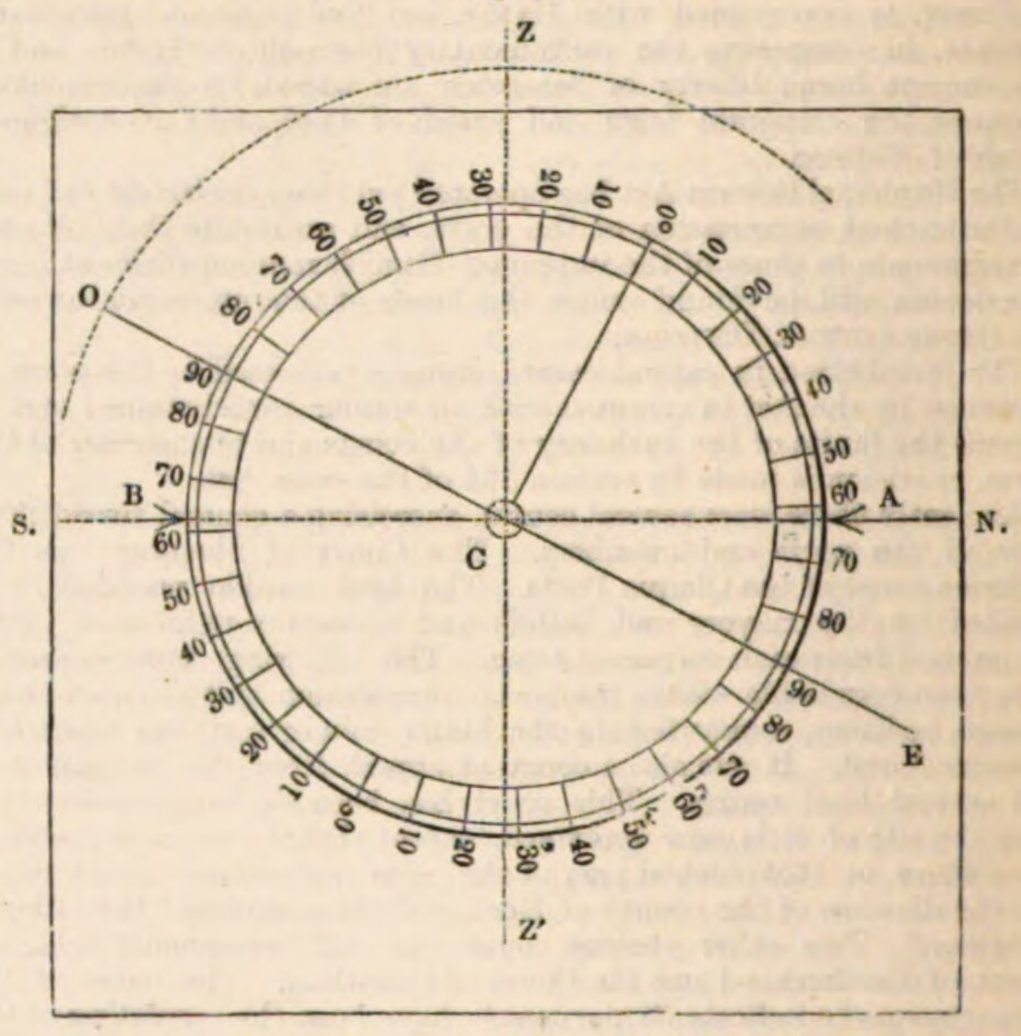
The ratio of the diameter to the circumference of a circle is very near indeed to that of 113 to 355, which numbers this diagram will keep in memory.

1 1 3 | 3 5 5

This method makes the circumference too great by about twenty-seven hundred-millionths of the diameter, and is therefore abundantly exact. But for common purposes, take the circumference at three times the diameter and one-seventh of the diameter, which does not err more than about one part out of a thousand of the diameter, and still in excess; that is, the circumference is a little less than twenty-two-sevenths of the diameter.

CIRCLE, ASTRONOMICAL. Though almost all the astronomical and geodesical instruments which are at present used in measuring angles, are composed of entire circles, the term *astronomical circle* is ordinarily confined to those instruments of which the sole or principal use is the measurement of angles of altitude or zenith distance. In the present article we shall adopt this limitation, and restrict ourselves still further to a description of the construction and use of those circles which are either fixed in the plane of the meridian, as the *mural* and *transit* circles, or which continue to have the plane of the principal circle vertical, though turning upon an axis, as the *altitude* and *azimuth* circle. For other instruments which might be included under the term circular, the reader must consult the articles EQUATORIAL, REPEATING CIRCLE, and THEODOLET.

Fig. 1.



This article will be more intelligible with some preliminary explanations.

Let a circular plate, divided into 360°, turn round a concentric axis C, fixed into the block S N, so that the line E O, moving with the circle, and in which direction the observer is supposed to look, can be placed in any direction up or down: A and B are two pointers attached to the block, and in a line passing through the centre. The block and circle are supposed to be upright; the axis C and the line A B horizontal. Also, when the line of sight is vertical, or E O coincides with z'z, 0° of the divisions ought to be exactly under the pointer A. It is evident, when the line of sight is moved through any angle into the direction E O, that C 0° must have moved through an equal angle, and that the $\angle$ Z C O = $\angle$ A C 0°, or the arc A 0°. Hence, if an object is seen in the direction E O, its *zenith distance* Z C O will be the angle pointed out upon the divided circle by the pointer A. This angle is technically called the *reading* of A. The line E O represents the direction of plain sights, or the line of sight of a telescope, sometimes called the *line of collimation* (from *collimare*, said by Facciolati to be a mistake for *collineare*).

If, when E O is vertical, A points a little above or below the 0°, or zero of the divisions, the difference from 0° is called the *error of collimation*, which may be corrected by shifting the position of A; but when the quantity and direction of the error are known, there is no need to make any alteration. For instance, let A point to 2° when the line of sight is vertical, then it is evident that when the line of sight is in the direction E O, the zenith distance will be equal to the arc from 2° to A, or 2° must be *subtracted* from the *reading* of A. If E O be directed anywhere between Z and N, then 2° must be *added* to the readings of A. In fact, the pointer may be placed anywhere in the circumference of the circle, and the divisions may commence in any part of the circle without at all affecting the accuracy of the measurement of angles of zenith distance; but a very large error of collimation would be inconvenient in practice. The second pointer B, if exactly in a diameter with A, and the divisions perfect, would evidently give the same result as A. This also may have an error of collimation, which may be treated precisely as that of A; or rather, the error of collimation for the *mean* of two or more pointers is determined at once and by the same operation. Two readings have this advantage over one, that if some of the divisions should be erroneously placed, it is not likely that equal errors in the same direction should fall at the same time under both pointers; and in any other supposition, the mean of the two readings will be affected by a less error than one of them. Hence the advantage of multiplying the readings for lessening the errors of division; it is evident that what is improbable for two, will be all but impossible for six, which is the number used in the Greenwich circles. There is.

however, another and more sensible advantage in two opposite readings above one. Conceive the whole circle to be moved towards Z, or Z′, or pushed sideways towards N or S; still, so long as E O continues to be parallel to itself, which it must be if it continues to be in the direction of a very distant object, the sum of the readings of A and B will remain the same; whatever one loses the other will gain. Hence it is not necessary that the axis should be truly circular, or that the centre of the axis should be exactly concentric with the centre of the divisions, which last requisite is not easily accomplished in the present construction of English dividing engines. In all circles which have readings diametrically opposite to each other, the observer ought to consider each *pair* as only *one* reading of a *diameter*, and not as two unconnected readings. There is another form in which a circular instrument for measuring altitudes may be constructed; the divided circle may be fixed to the block, and the line of sight, E O, turn upon the axis C. In this case the pointers must be connected with E O, and revolve on the same centre. All the previous remarks are equally applicable.

The operation of noting the angles, or of *reading off*, has been described in its rudest form, as it seems to have been practised by the Greeks. We must here explain somewhat more minutely the use of the micrometer microscope. (For other modes of subdivision, see VERNIER.)

Fig. 2.

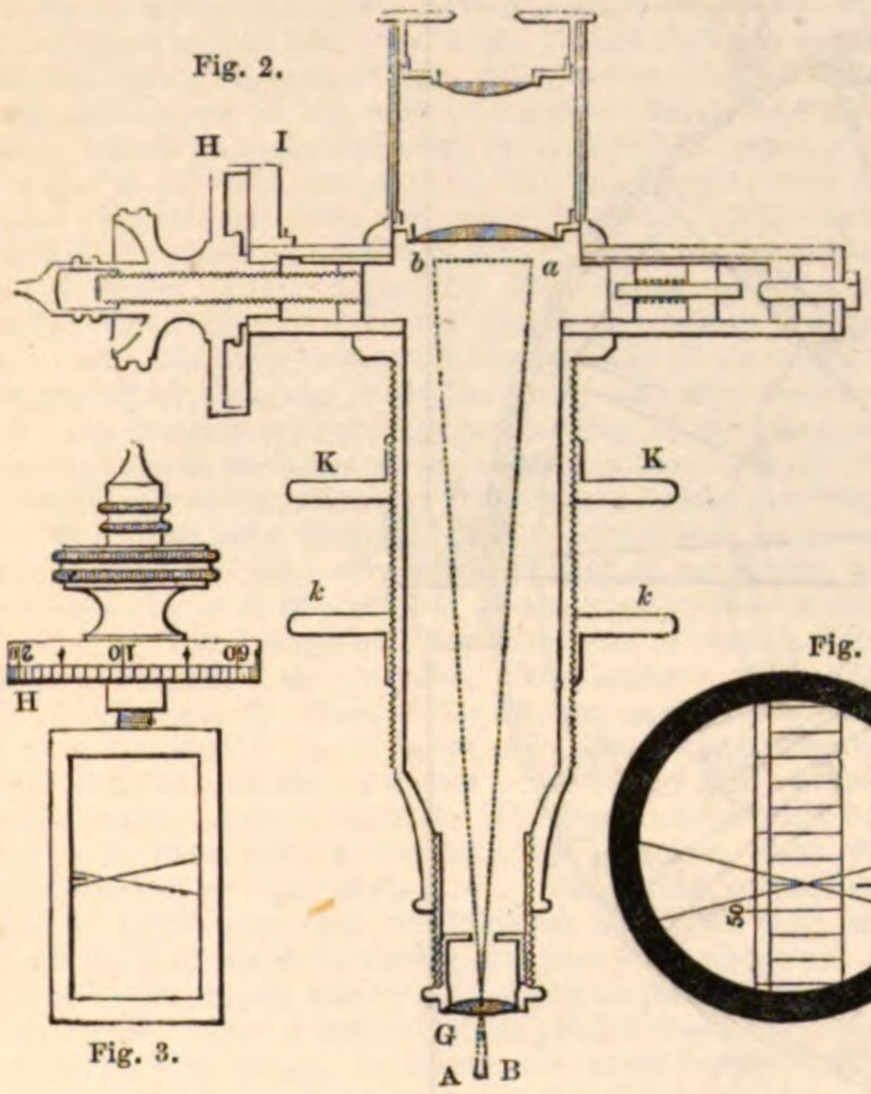


Fig. 3.

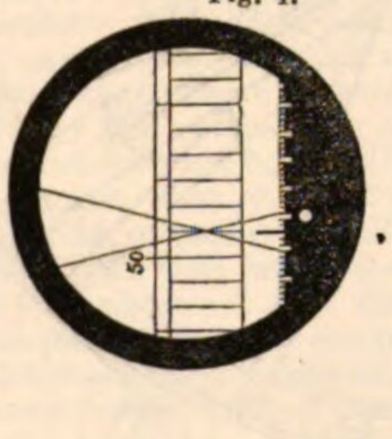


Fig. 4.

Fig. 2 is a *micrometer microscope:* A B is supposed to be the space between two divisions of the circle which is generally equal to 5′. The object glass G, which is sometimes, and with great benefit, made achromatic, forms at *a b* an inverted image of A B, as *a b*. Within the body of the microscope there is a slide, represented in *fig.* 3. This slide is drawn forwards by a fine screw (generally of 100 threads to an inch), while it is held back by a spring to avoid *lost time;* it has two fine wires crossing at an acute angle, as in the figure. The image A B should fall exactly on this cross, and the two lens eye-piece should be so placed as to give distinct vision of both. Also five revolutions of the screw should move the cross *exactly* from any division of the circle to the neighbouring one. The circular plate H is fixed by friction upon the head, and is divided into 60 parts, which correspond to seconds on the circle, and are read off by a pointer, I. The entire revolutions of the screw are counted by a sort of comb, or indented plate fixed near the wires, but not moveable with them. There is a little projecting tongue of metal opposite the cross wires, which is seen between the teeth of the comb at each whole revolution of the screw. This microscope having its parts at the proper distance from each other, and being placed at the proper distance from the divided circle, must be supposed to be substituted for the pointer A in *fig.* 1 (p. 924); the tongue at 0 in the comb, and the zero of the divided head opposite to its index. If a division of the circle seems exactly to cut the cross at the angular points, the observer has only to note what division of the circle it is, and that is the reading, just as with the simple pointer. Generally, however, one division will appear above and another below the cross. Since the divisions are seen inverted, the division apparently below the cross is the one really above, which, according to *fig.* 1, and the position E O, is the division immediately less than the position of the microscope or pointer. Turn the screw round until the appearance is exactly the same as in *fig.* 4, and suppose that the tongue has moved over two teeth, showing two revolutions of the screw, and the index is half way between 33 and 34 on the divided head, then 2′ and 33·5″ are to be added to the degrees and minutes of that division. Now that division

is 50° 5′; therefore the true reading is 50° 7′ 33·5″. What has been said as to error of collimation holds good with a microscope as with a pointer. When the line of sight E O falls between Z and N, then the next least division will be really below, but apparently above the cross, and the measurement should be made to it. The screw in this case must be turned the other way, and instead of the divisions of the head shown by the index, their difference from 60 must be taken for the seconds. A little caution and experience will guard the observer against mistake. The length of the microscope can be altered by screwing the tube in which G is fixed, and the microscope can be shifted in its support to and from the circle by the nuts K K, *k k*. It is evident that by these two movements the size of the image can be altered as well as its situation with respect to the cross wires. (See the figure of the altitude and azimuth circle for the mode of mounting the micrometer.) The apparatus of the micrometer microscope, shown at *fig.* 3, is frequently attached to the eye-end of a telescope, and is placed in the focus of the object glass. The wires are then placed across the slide and at right angles to it, so as to be parallel with other wires of the telescope. If these points are clearly understood, the reader will find no difficulty in understanding the rest of this article. [MICROMETER.]

The earliest application of a circle to astronomical purposes is described by Ptolemy ('Almag.,' i. 10), who calls it, from its use, a solsticial circle. This consists of a smaller circle turning freely within, and in the same plane with, a larger and fixed divided vertical circle. Two small projecting prisms are placed in a diameter of the inner circle for a line of sight, and pointers are also fixed on the inner circle, which move on the face of the outer circle. The instrument thus formed is to be carefully adjusted by a plumb-line and meridian-line in the plane of the meridian. In observing the sun, the inner moveable circle was turned round until the shadow of the upper prism exactly covered the lover prism, when the pointers marked the corresponding division upon the outer fixed circle. The inner circle seems to have been employed as the most accurate mode of giving a rotatory motion to the *line of collimation*, concentric with the divided circle. If a bar, carrying the line of sight and the pointers, be supposed to revolve on an axis, it is the second case of *fig.* 1. The language of Ptolemy does not inform us who was the inventor of this instrument, or even that it was ever made or used. Delambre conjectures, with some probability, that it is due to Eratosthenes, though he inclines to think that the celebrated measure of the obliquity of the ecliptic by that astronomer—namely, that the distance between the tropics is equal to $\frac{11}{83}$ of the circumference—was deduced from observations with the gnomon. However that may be, it is certain that the *solsticial circle* was the best-contrived instrument of which we find any account until the time of Roëmer; and it bears, as will be seen, a very close analogy to the modern mural circle of Troughton.

Except the complicated astrolabe of Hipparchus, which consisted of five concentric circles, so contrived as to have one circle in the plane of the ecliptic, and another at right angles to it, we do not find the entire circle employed in large instruments before the time of Tycho Brahé, and then only for an equatorial. The supposed authority and example of Ptolemy, who proposed a quadrant, and the desire of increasing the sensibility of instruments, by enlarging the scale of the divisions, blinded astronomers to the more solid advantages of the entire circle.

In 1704 Roëmer erected his *Rota meridiana*, or *transit circle*, in his private observatory 1ᵐ due west of the astronomical tower of Copenhagen. He had invented the simple transit and the altitude and azimuth circle about fourteen years earlier, and in this new instrument he very happily combined the qualities of a transit telescope with those of a meridian altitude circle. In a letter to Leibnitz, 15th December, 1700, he had already said, "that the quadrant and sextant ought no longer to be used, and that he would rely more on an entire circle of four feet than on a quadrant of a ten-feet circle." ('Miscell. Berolin. continuat.' ii. p. 276.) A description and figure of the Rota meridiana are to be found in the 'Basis Astronomiæ,' p. 143, tab. viii., of his pupil Horrebow, 'Hafniæ,' 1735, with a specimen of three days' observations. The altitude and azimuth circle is described in p. 43, and figured in tab. ii. of the same work.

The *Rota meridiana* of Roëmer was a divided circle set upon a hollow double cone, at right angles to the axis of the cones, and concentric with them, the circle being near one end of the axis. The divisions were read by two microscope verniers, fixed in a diameter of the circle on one of the supports of the axis. For general purposes, this is perhaps as well a designed instrument as has ever been constructed, yet it was not imitated till a similar construction was recommended by Mr. Pond, and adopted for the observatory at Paramatta. A second, on a much larger scale, was somewhat later made for the observatory at Oxford; both these were by Mr. T. Jones. Notwithstanding the advice and practice of Roëmer, it does not appear that the entire circle was used for astronomical purposes until Mayer proposed his *repeating reflecting circle.* His description was published in 1770 ('Tabulæ Solares,' p. 21, plate ii.), but the repeating reflecting circle did not come into use until modified and perfected by Borda about 1787.

In 1784 the Danish astronomer Bugge published his 'Observationes Astronomicæ, Hauniæ,' in which he gives a figure and description of a vertical circle of four feet diameter revolving in azimuth, p. liii.

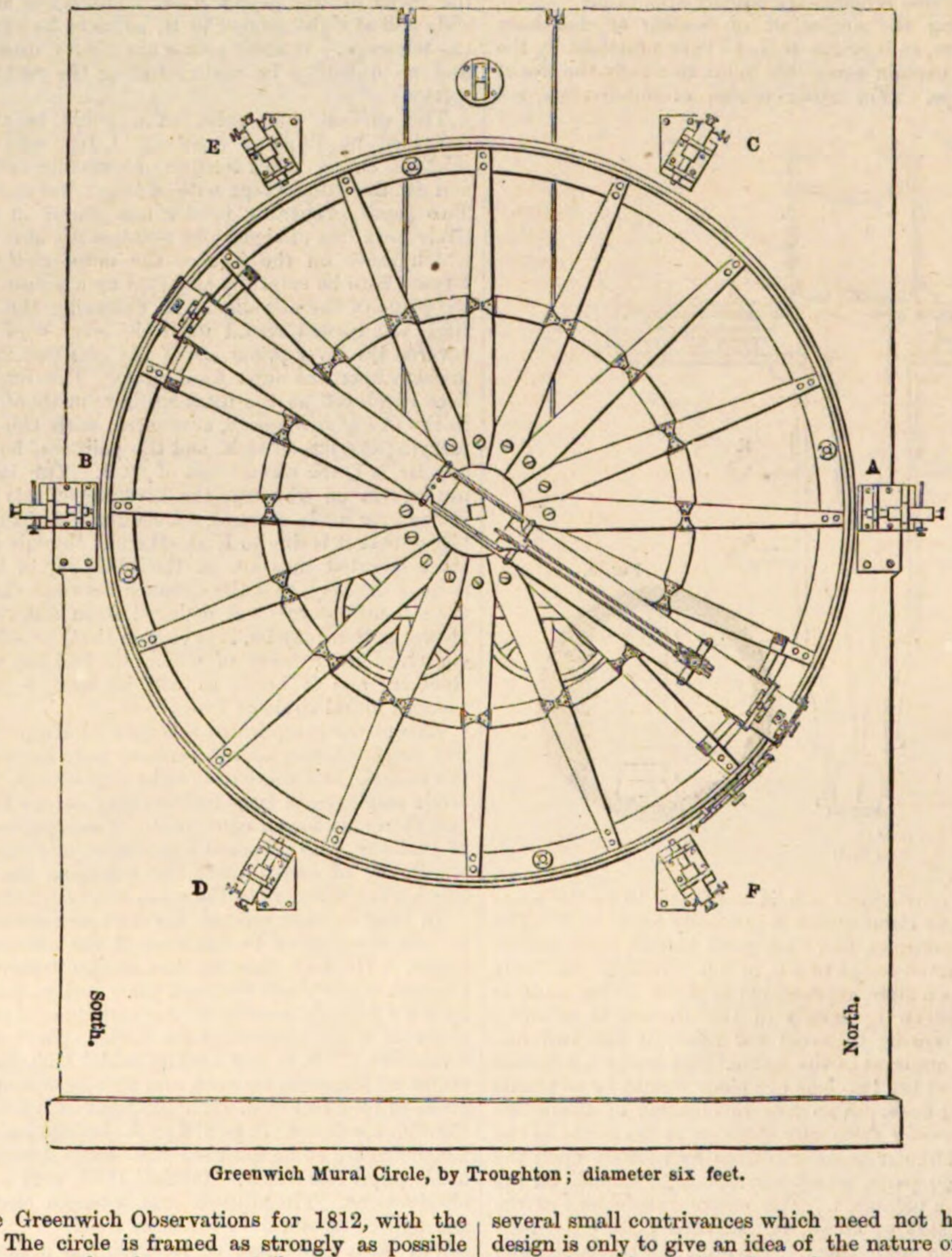
Tab. viii. and ix.; it seems a smaller one had been used in the survey of Denmark as early as 1762.

Ramsden undertook an altitude and azimuth circle for the observatory of Palermo in 1788, and completed it in 1789. This is described by Piazza ('Della Specola Astronomica di Palermo,' 1792), with four plates of the instrument and its details. (See, also, Pearson's 'Astronomy,' vol. ii., p. 413, plate xxiii.) It is with this circle that the declinations of Piazza's celebrated catalogue were determined. In 1792 Troughton perfected his altitude and azimuth circle; and in 1793 Mr. Francis Wollaston published in the 'Philosophical Transactions' a description, with a plate, of his transit circle: Borda's repeating circle seems to have been first used about 1787, in connecting the meridians of Paris and Greenwich. The advantages of the circular form were now appreciated; its superior strength and symmetry, the elimination of any error of excentricity by opposite readings, and

the diminution of errors of division by increasing the number of readings, or by reversing the instrument, were placed beyond dispute. Various alterations were made in parts of these instruments, and new contrivances and conveniences applied, but nothing very novel in principle was struck out till Troughton erected a six-feet mural circle at Greenwich in 1812. After some controversy this form has been generally adopted in those British observatories which can afford a second observer for the transit.

The limits of the present work will not allow a detailed account of any one instrument, and still less a description of the numerous variations which have been introduced according to the views of astronomers and artists. We shall give a general view of the two most essential forms, the mural meridian circle and the altitude and azimuth circle, as constructed by Troughton and his school.

The accompanying figure of the mural circle of Troughton is copied



Greenwich Mural Circle, by Troughton; diameter six feet.

from that prefixed to the Greenwich Observations for 1812, with the subsequent alterations. The circle is framed as strongly as possible (it might perhaps, in some cases, be advantageously cast in one piece), and is fixed at right angles to, and concentric with, a long, hollow, conical axis. This axis rests and turns in two collars, one towards each end of the cone, fixed at the front and back of a stone pier, three or four feet in depth, and there are four screws at the back for adjusting the horizontal axis in inclination or azimuth. The circle is divided on its edge to 5′, upon a narrow ring of gold or other metal let into the rim; the divisions are read by six micrometer-microscopes at A B, C D, E F. The telescope is fixed at right angles upon an axis which works within the hollow conical axis of the circle, and can be moved upon the circle into any position; it is held fast by clamps towards the object and eye-end. At the eye-end there are three or more vertical, and one horizontal wire, and a micrometer, which carries a second horizontal wire parallel to the fixed wire. To prevent wear, and to give ease and smoothness to the motion of the circle, two large friction wheels are suspended in front of the pier from the arms of two levers, which by counterpoises may be made to support the whole or part of the weight of the instrument. They press upwards upon a ring on the axis, between the circle itself and the pier. There are several small contrivances which need not here be mentioned, as our design is only to give an idea of the nature of the instrument. For a more minute description the reader must consult Pearson's 'Astronomy,' vol. ii. pp. 472, 488, plate xx. The above description belongs to the mural circle as constructed by Troughton. In one or two later instances the collars have been exchanged for Y.s, that is, angular notches in pieces of metal, in the hope of making the instrument serve for a transit; but this has not, we believe, yet been performed satisfactorily. Dr. Robinson in the circle made for the observatory at Armagh, preferred having the divisions cut on the back of the instrument, and the microscopes fixed on the edge of a circular pier, with several other alterations (for which see 'Mem. Ast. Soc.,' vol. ix.) The divisions of the circle are cut by Troughton's method. [GRADUATION.]

After the instrument is erected on its pier, the axis must be placed horizontally, or the plane of the circle vertical. This may be done by a plumb-line apparatus, which generally accompanies the instrument; or more accurately by making a star pass the meridian wire at the same time when seen directly, and also when seen reflected in a trough filled with mercury or water, &c. The four screws at the back of the pier supply the means of effecting this. The second adjustment, or

placing the line of sight at right angles to the axis, may be performed by two distant marks to the north or south of the circle, which have been previously correctly placed by means of a transit; or by a collimating transit [COLLIMATOR]; and finally, the instrument may be placed in the meridian, either by a mark, or by observations of circumpolar stars above and below pole, or by observations of high and low stars, just as a transit. [TRANSIT.] Or the position of the plane described by the line of sight with respect to the meridian, may be determined by comparing the passages of stars over the meridian, as observed with the circle and with the transit at the same time: when the law of the errors being known, and also the amount of their sum, their respective values are easily ascertained and corrected. It may, however, be remarked, that small errors in any or all these adjustments will not vitiate the results; and that the moon is the only celestial body sensibly affected by ordinary variations from the true meridian.

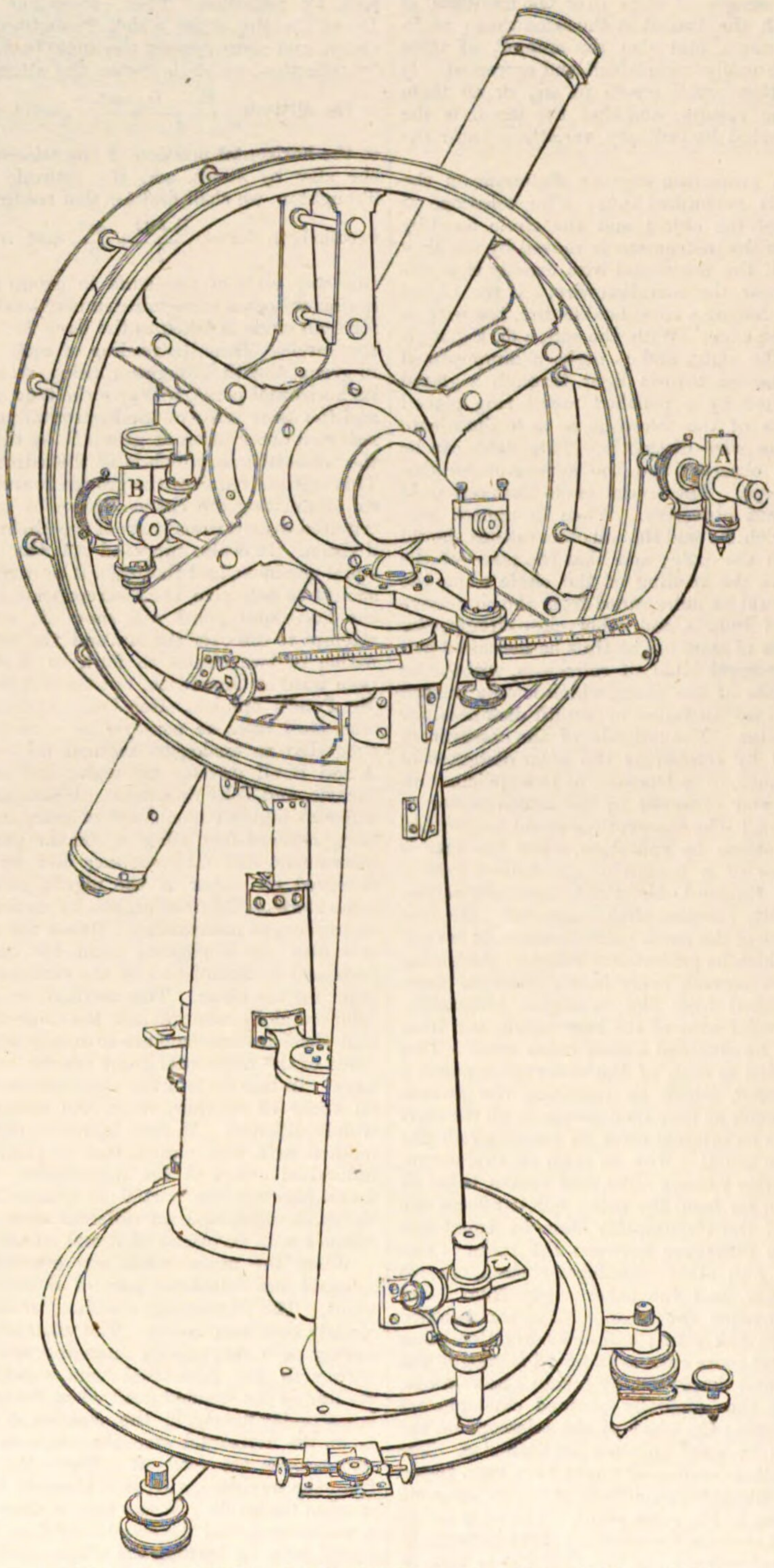
The mural circle is used in measuring angular distances on the meridian, and the observation is performed thus: The telescope is pointed nearly in the direction of the object, and the circle fixed by the clamp in that position: then the instrument is moved by the slow motion-screw of the clamp, until the horizontal wire exactly cuts the star in two, or *bisects* it, at or near the meridian wire. If the object be the sun or moon, or a planet having a considerable disc, the wire is made a tangent to its illuminated edge. With the sun, a dark glass is put on the eye-end to protect the sight, and at night a lamp placed opposite the centre of the telescope throws light through a glazed aperture, which is again reflected by a polished metal ring placed at an angle of 45° with the axis of the telescope, so as to illuminate the field of view and show the wire distinctly. This light can be modified at the pleasure of the observer, and the apparatus for this purpose is shown on the telescope. The mural circle has been used somewhat differently by different observers. When Troughton proposed a mural circle for Greenwich, he said that all observations should be considered as distances from the pole; and that the place of the pole on the instrument (that is, the reading of the circle when the telescope points to the pole) should be determined from the successive upper and lower culminations of Polaris, and other close circumpolar stars. The north polar distances of stars might thus be measured and registered with the help of a correct table of refraction, without an accurate knowledge of the latitude of the place, which is only wanted for converting polar distances into altitudes or zenith distances, for computing refraction and parallax. The latitude of the observatory might be subsequently deduced by comparing the polar distances of stars near the zenith, for instance, of γ Draconis at Greenwich, with the zenith distance of the same star observed by the zenith sector or the zenith tube. [ZENITH SECTOR.] The observations could be checked by combining them with observations by reflection, when the star is seen reflected from the surface of a trough of quicksilver. In a climate so variable as that of England, Mr. Pond, then astronomer royal, found it advisable to modify the plan thus suggested. He first formed an approximate catalogue of the north polar distances of several stars by these or other means, which he perfected as follows: Assuming the approximate catalogue to be correct, every future observed place, compared with the place computed from the catalogue, presented a difference, which he called the *index error* of the instrument, and from the observations of several stars he obtained a *mean* index error. This mean index error was then applied to each of the observations, and a corrected catalogue thus produced, which by repeating the process leaves no constant error except such as may be common to all the stars employed; such, for instance, as an original error in assuming all the polar distances too large or too small. Now an error of this nature affects all the stars at their superior passage alike, and makes them all equally appear too near to or too far from the pole; but it affects the superior and inferior passages of the circumpolar stars by equal and contrary quantities. Hence the difference between the mean of two sets of observations of Polaris and other circumpolar stars, one set being deduced solely from upper, and the other solely from lower culminations, is clearly equal to twice the mean error in the assumed place of the pole with respect to the stars; and this correction being applied to all the stars, a new and more correct standard catalogue was formed, to be again corrected and improved by future observations. It is evident that the errors of the originally assumed catalogue are now wholly eliminated. By shifting the place of the telescope on the instrument, fresh divisions were brought into use for each star. The accuracy of the tables of refraction employed might have been tested by the agreement of near and distant circumpolar stars, in assigning the same value for this correction to the polar point. The only defect in this method seems to be, that it assumes the accuracy of the instrument or the accuracy of the tables of refraction; and that if either or both be imperfect, the final results are not in a form suited to investigation.

Another mode was adopted by Mr. Pond after 1824, when a second mural circle, made by Mr. T. Jones, of Charing Cross, was erected at Greenwich. Suppose several stars to be observed the same evening in two groups, which call A and B. All the stars in group A are observed by both circles by direct vision; the stars of group B are observed directly by one circle, suppose Jones, and by reflection, by Troughton. Let the mean of the readings of group A, by Jones, exceed the mean of the readings of the same group by Troughton, by m''; then it is

clear, the instruments continuing in the same state, that if from the observation of any other star, by Jones, you *subtract* m'', you will have the reading which Troughton would have shown, barring accidental errors, and *vice versâ*, that on *adding* m'' to any observation by Troughton, you will get the corresponding observation, with the same exceptions, which would have been made by Jones. Again, let a star in group B be taken, and let D be the angle read off by Jones, the star being then seen directly, and R the angle by Troughton, the star being seen by reflection. Then, according to what has been said above, $D-m''$ is the angle which Troughton would have given by direct vision, and consequently the angle between the star seen directly and by reflection, which is twice the altitude of the star, $= R - D + m''$, or the altitude $= \frac{R-D}{2} + \frac{m''}{2}$. Again, as the reading which corresponds to the horizontal position of the telescope is evidently D + altitude of the star by Jones, and R — altitude or depression of the star by Troughton, we shall find for that reading, or the *horizontal point*, as it is called, in Jones, $\frac{R+D}{2} + \frac{m''}{2}$, and in Troughton, $\frac{R+D}{2} - \frac{m''}{2}$. In this way each of the stars in group B gives a fresh value for the horizontal point in each instrument, and the *mean* of the determinations for each circle is taken as the basis for reducing every observation by that circle. Thus the reading of each direct observation of the stars in group A with Troughton, being *subtracted* from the mean value of its horizontal point, will give the true altitude of the stars in group A, and the same value of the horizontal point being *subtracted* from every reflected observation of group B, by this circle, leaves in like manner the true altitude, which is all the astronomer demands from the circle. This method requires the groups A and B to be sufficiently numerous for eliminating the chance errors of mere observation, and to be distributed over various parts of the circle to destroy faults of form or of division. It is also supposed that the circles are instruments of nearly equal goodness, and that each is as perfect as art can make it. If they should be defective, the discrepancies in the partial determinations of the horizontal point will show it, and the astronomer must then attempt to discover the law and the cause of the defect. The combination of two circles to form, as it were, one instrument, has only been tried at Greenwich, but there it has proved eminently successful; Mr. Pond's opinion, after long experience, being, that *the pair were more than twice as powerful as a single one.* The same astronomer suggested an analogous method for one circle. Observe the groups A and B all *directly* one night, and on a following night observe A *directly*, and B by reflection. A comparison between the groups A on different nights (the change of place in the stars and in the refraction being allowed for) will give you the variation or change of place of the instrument and microscopes; and by applying this to the stars B, observed on either of the nights, you will have observations of the same stars on different nights, by direct and reflected vision, but with an *unchanged* instrument. Hence the double altitudes of B are found, and also the horizontal point for one of the nights which when increased or diminished by the variation above found, is the horizontal point for the other. This method, or one similar to it, is, we believe, followed at Edinburgh and the Cape of Good Hope; and it is found that these instruments are so steady and unfluctuating, that the same value of the horizontal point results from the observations of several days. In this system the observations of one day are made dependent on those of another, when the atmospheric circumstances may be widely different. It has, however, one advantage over the previous method with two circles, that it places more directly in evidence the individual errors of the instrument. The differences which may be found between the partial determinations of the horizontal point on the same night, and on different sides of the zenith, will show what reliance is to be placed on it and on the observer.

When the mural circle was erected at Cambridge, Professor Airy selected the following plan of determining the horizontal or zenith point. The micrometer attached to the eye end of the telescope has already been mentioned. The value of a revolution of this micrometer having been very exactly measured, and the parallelism of its moveable wire with the horizontal wire carefully ascertained, and also the reading of the divided head when the two wires coincide, the telescope is set pretty nearly in the position at which a star by *reflection* would be on the horizontal wire, the circle is then firmly clamped, and the microscopes are read off. When the star is at a convenient distance from the meridian wire, it is bisected by the micrometer wire without stirring the circle. When this is done, and the time noted, the circle is unclamped, and the star bisected by *direct vision* on the fixed horizontal wire, by turning the whole circle round, and the time is again noted. If the star had been observed in both instances upon the meridian and upon the fixed wire, it is clear that the reading corresponding to the horizontal position of the telescope would be half way between the readings of elevation and depression, or $= \frac{R+D}{2}$. The correction to the meridian is easily found and applied, the times being known. Again, if the distance between the fixed and micrometer wire be equal to n'', it is clear that the reading of R is greater or less by n'' than it would have been if the observation had been made with the

fixed wire, and that the further correction for the micrometer is made simply by the addition or subtraction of $\frac{n''}{2}$ to the value already found of the horizontal point. In the Cambridge Observatory, Professor Airy tabulated the reading coresponding to the zenith position of the telescope. From a mean of such determinations the reading of the zenith point is settled, and all observations made in the ordinary way, reduced to altitudes or zenith distances. For this mode of observing, the micrometer should be exquisitely perfect, and carefully watched. On comparing the zenith points deduced from low and high stars, to the north and south of the zenith, Professor Airy discovered some anomalies, the causes of which have not yet been fully ascertained. ('Cambridge Observations,' 1833, p. 27.) They seem, however, to



Eighteen-inch Altitude and Azimuth Circle, by Troughton and Simms, 1836.

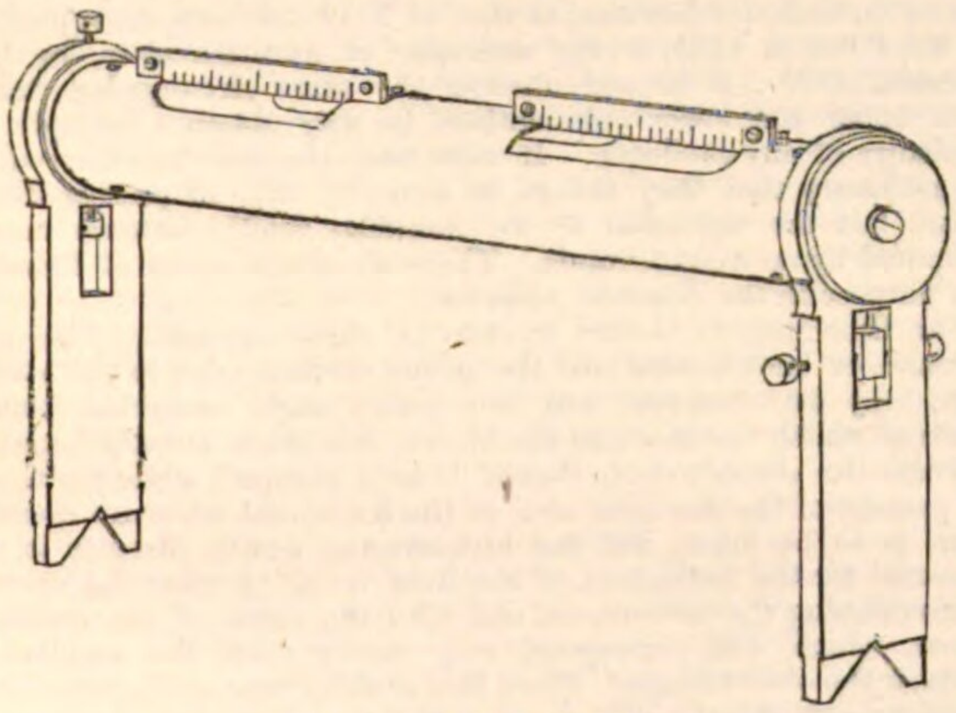
exist in other mural circles, and possibly in circles of a different construction.

The micrometer microscopes, in what has been said, are supposed to be exactly adjusted, so that five revolutions of the screw carry the cross of the wires precisely over a space of 5′ on the circle. It is not possible to make this adjustment with perfect accuracy, nor would it be permanent; but it is not necessary. By examining the value of the *runs*, as they are called,—that is, the measures in revolutions and parts of the screw of the 5′ spaces in the circle,—a mean value of the measures of 5′ by the six microscopes is obtained, from time to time, which may be a little greater or less than five revolutions. In this case, the mean of the micrometer readings—that is, of the single minutes and parts—must in each observation be altered in the proportion of the value thus ascertained to be 5′. If, for instance, the mean value of the 5′ spaces on the circle were apparently 5′ 5·1″ by the microscopes, $\frac{1}{60}$ must be subtracted from the minutes and seconds indicated by the mean of the

microscopes. For actual adjustment, the following directions may be useful: A micrometer microscope is adjusted when the image of the divisions of the circle is formed upon the cross wires of the microscopes, and its size is exactly equal to five revolutions of the screw. Suppose the vision of the wires and of the divisions to be perfect, but that the space of 5′ is passed over by four revolutions and fifty parts of the screw. It is evident that the image is too small, and it must be made larger by drawing out by the screw the object glass G, and bringing it nearer the limb. In this case, however, the image is formed between the wires and the eye-piece, and therefore the whole body of the microscope must be drawn from the circle until the image falls on the cross wires. It will now be found that the image of 5′ is larger than before, and it must be again measured by the screw. In this way, by gradual attempts, the microscope may be perfectly adjusted, but the operation, if complete accuracy be aimed at, is very fatiguing and troublesome.

The general form of the altitude and azimuth circle will be seen from the woodcut. The lower, horizontal, or azimuth circle, is fixed on three strong radii, which have foot-screws at their extremities, and a strong vertical steel axis rising from their intersection. On this axis the whole of the upper works move freely and smoothly on a conical cap accurately fitted and ground to the top and bottom of the axis. On the lower part of the cap is fixed a broad circular plate on which the two pillars rest which support the circle and telescope. The microscopes for reading the azimuth circle are fixed on the pillars. Outriggers stand on the top of pillars, each of which carries a notch or Y, which can be raised or depressed by a screw. The vertical, altitude, or declination circle is framed with a view to strength and lightness, and its divided face is read by two microscopes placed on the end of the curved tube, which is formed something like a pair of horns, and fixed across the top of one of the pillars. The circles are usually divided to 5′, and subdivided by the micrometer microscopes to seconds. The graduation of the horizontal circle generally runs from 0° to 360°; the vertical circle is differently divided, according to the pleasure of the artist or observer. A little consideration will enable any one to apply the rules given for reading microscopes to each particular case. We shall speak indifferently of altitude and zenith distances, since they are immediately derivable one from the other. The wires of the telescope are illuminated by a lamp which shines in at one end of the cross or transit axis of the vertical circle, and is reflected on the wires by a pierced polished ring set diagonally. There are two sensible ground levels, one of which is attached to the horns supporting the upper microscopes; another, which is free, can be applied through the openings of the circle to the pivots of the cross axis. The cross level and its adjusting screws will be understood by the accompanying figure.

There are clamps and slow-moving screws to each circle to fix them, and to give the power of bisecting any object with the telescope.



Detached or Transit Level.

The first adjustment is that of setting the vertical axis perpendicular to the horizon. Turn the instrument until the fixed level is nearly parallel to two of the foot-screws, and place the bubble in the middle by the foot-screws. Then, moving the instrument half round in azimuth, bring the bubble again to the middle, half by the foot-screws, and the other half by the screws which raise or depress one end of the level. If this is carefully done, and the circle restored to its original position, the bubble will be still in the middle; but if not, it must be brought there, half by the foot-screws, and the rest by the level-screw. Now, turning the instrument a quarter round, through 90°, bring the bubble into the middle of the scale by touching the third foot-screw. This is generally placed in front and towards the observer, and rests on a small lever apparatus, represented in the figure, which supplies a very delicate slow motion, contrived, we believe, by Borda. When the operation is successfully performed, the bubble will remain in the centre, whatever azimuth the instrument is directed to. It is not necessary in practice to touch the screw which adjusts the level if the error be very small. The divisions of the level-scale corresponding to

both ends of the bubble should be noted before and after reversion, and the mean taken. Let the foot-screws be called E and W, and the ends of the level towards them be distinguished by the same letters, and the scale of the level be numbered from the centre to each end, and suppose the readings be—

	E.	W.	
In the first position .	67·4″	48·2″	
In the reversed position	59·6″	56·0″	
Mean	63·5	52·1	difference = 11·4″.

The mean readings would have been the readings of the level, if the level itself had been in adjustment. It is evident that E is too high, or W too low, by half the difference, or by 5·7″, and one of the foot-screws must be turned enough to shift the bubble 5·7″ in the right direction. Troughton always moved both E and W an equal quantity in contrary directions for this adjustment, which in many cases is very much better. If that is carefully done, the E readings will be diminished, and the W readings increased by 5·7″, and they will stand thus:—

	E.	W.
In the first position . .	61·7	53·9
In the reversed position .	53·9	61·7

or the bubble keeps the same position *in its scale* before and after reversing, and the axis is vertical to the line joining the two foot-screws. The bubble must be placed at the same divisions when over the third foot-screw, and the axis is truly vertical. The difference between the last-mentioned readings is 7·8″, and the half of this, or 3·9″, is the quantity through which the bubble should be moved by the level-screw to complete its adjustment, if that be desired; but if the true value of the divisions of the scale be known, and it is also known that this does not sensibly vary with the temperature or from other causes, it is useless to adjust very scrupulously, since the ends of the level must always be read and noted, and the difference allowed for by a careful observer. In some larger instruments of this construction, the vertical axis is adjusted by a plumb-line, which Ramsden and Troughton applied in different ways. One of these applications will be described under ZENITH SECTOR; but we are inclined to think that the ground-level is more accurate, while it is incomparably more convenient than the plumb-line, for small circles, which move freely in azimuth, and are used agreeably to their construction. The vertical axis being properly placed, the cross axis of the upper circle is next to be set horizontal. Pass the detached level carefully through the openings in the circle, place its notches on the pivots of the axis, note the ends of the bubble, exactly as before, reverse the level, and note the ends again. Suppose the results to be—

	East End.	West End.
First position . .	6·24	8·43
Reversed position . .	7·96	6·71
Mean . . .	7·10	7·57

Hence the difference between the mean readings is 0·47, or the west end is higher than the east by 0·235. The bubble must be moved this quantity towards the east by raising the east or depressing the west pivot. There is a screw under each pivot for that purpose. It is convenient to have the scale divided into parts, of which the units are 15″ of a degree.

The microscopes should be adjusted, if that be required, in the manner already described, but we recommend amateur observers, at least, to have the body of the microscopes made unalterable, after the maker has settled both the adjustments, by pinning together the body and tube which carries the object-glass. Both adjustments will then be performed by making the 5′ spaces equal to five revolutions of the micrometer screw, simply by shifting the body of the microscope a little nearer to or farther from the instrument. This should be done pretty carefully, but any remaining error may be corrected as in the mural circle. The microscopes (there are generally a pair to each circle) are finally to be placed in a diameter of their respective circles, and nearly in the middle of the concentric lines, which contain the divisions. There are screws in the tubes by which the microscopes are mounted, which allow them a little motion in any direction, and the cross wires are thus brought to bisect divisions 180° apart. This requires no particular exactness, and may be done at once for the azimuth circle. The upper microscopes may be adjusted approximately. The optical part of the instrument must now be put into order. At the eye end of the telescope there are generally five or seven vertical and three or five horizontal wires, that is, fine lines of cobweb, raw silk, or any very delicate and uniform fibre. To place these in the focus of the object-glass, apply the highest magnifying power you have got, bring the wires to distinct vision, and look at a bright star. The wires and eye-piece are fixed on a piece of tube which moves stiffly within the tube of the telescope, and this must be pushed in or drawn out till the star is seen perfectly round and surrounded with rings, the wires being at the same time sharply defined. This adjustment may be completed or verified thus: The pole star, or any circumpolar star, may be bisected by the vertical wire when near

its greatest elongation, or by the horizontal wire when near the meridian. In the former case the eye is to be moved on each side, in the latter up and down; and if the star continues bisected, and there is no dancing of the star on one side or other of the wire, the position is correct. When the star moves contrariwise to the eye of the observer, the tube must be pulled out, as the image of the star is then formed between the wires and the eye, and the wires must be brought to the same place. When they move the same way, the tube is to be pushed in until the image is formed exactly upon the wire. Any error must be corrected by gradually pushing the tube in or out. When this has been once successfully done, a notch for verification should be made to save all future trouble. The vertical wires are now to be set at right angles to the axis. Take any well-defined object, either a sharp distant terrestrial mark, or the wires of a subsidiary telescope [COLLIMATOR], or a circumpolar star at its greatest elongation. Bisect this at the centre of the middle wire, and move the telescope up and down until you see the object at the top and bottom of the field. If it is not bisected there twist the moveable tube round, and so bisect it, and repeat the operation until you are satisfied. The middle horizontal wire, if a correct position of that is preferred, must be adjusted, by twisting the tube until a star on the meridian runs along the horizontal wire by its own motion, the azimuth circle being fixed; or by moving the instrument in azimuth after having bisected Polaris or a circumpolar star near the meridian, on that wire. There are screws above and below the tube at the eye end, which should now be tightened. To make the central and vertical wire describe a great circle, bisect a well-defined object, as near the horizon as may be, read the horizontal microscopes, turn the instrument 180° in azimuth, and observe again, reading the same microscopes. If the means of each pair of readings, before and after reversion, differ *exactly* 180°, the wire describes a great circle; if not, move the instrument half way to 180° by the clamp screw, and bisect the object by turning two antagonist and pulling-screws near the eye-piece, which draw the wire plate to either side; repeat the operation until you are satisfied. If the horizontal clamp is strong enough, the circle may be taken out of its axis and reversed as an ordinary transit [TRANSIT]. The upper microscopes may now be correctly adjusted. Observe any object which does not alter its altitude on the middle horizontal wire, and read the upper microscopes; turn the instrument through 180° of azimuth, and observe the object again. Move the circle to exactly the middle of these two readings (which will be near either 0° or 90°), when the telescope is in the zenith, and then by the adjusting screws set the crosses of each of the microscopes exactly on 0° or 90°, as the case may be; the microscopes are then in a diameter, and the error of collimation in altitude is also destroyed. As this correction is altered by any alteration of the apparatus for levelling the horizontal axis, and as few observers like to meddle with the adjustments of their microscopes, the microscopes can be brought into a diameter after the axis is made horizontal by raising or lowering each of the levelling screws a small equal quantity; but though it is convenient that the microscopes should read nearly the same angle, it is not at all essential to accuracy, and the error of collimation must always be ascertained or eliminated by the mode of observation.

We shall always suppose every observation to be a *mean* of two, one made face east and the other face west, unless the contrary be said or implied. In this case there is no error of collimation.

The altitude and azimuth circle was, as has been stated, invented by Roëmer, though a quadrant moving freely in azimuth, and with a graduated horizontal circle, was used by Hevelius. It is the most universally useful of all astronomical instruments, and is both portable and accurate. In delicate hands, and with some power of calculation, it is capable of performing a great deal of good work. Besides being an excellent geodesical instrument [THEODOLET], it is, when placed in the meridian, an accurate, though not very convenient transit. It may be used in this position as a meridian or transit circle, for determining at once the right ascension and zenith distance of any unknown stars. In this case the horizontal point must be got by combining observations taken directly with others by reflection, in the manner already described in the mural circle; or else several standard stars may be observed, and their instrumental places compared with their computed places; the mean of these differences is to be applied as an index error to correct the observations of unknown stars exactly as in Mr. Pond's first method with the mural circle. In this mode of observing there is no reversion.

The principal merit in the altitude and azimuth circle is, that it can be moved in azimuth without injuring its accuracy as a measurer of zenith distance. Let us suppose a navigator in a strange place with such an instrument and a time-keeper, of which the error is unknown. This should mark sidereal time. The instrument must first be nearly adjusted, and the approximate meridian selected. This will be known near enough by shifting the instrument in azimuth till it is found that a star, which is bisected by the horizontal wire, continues to be bisected for a short time. Observe the zenith distance of some known star in this direction, and this will give an approximate latitude. The time and the azimuth of the star should also be noted. Now observe the zenith distance of another known star near the prime vertical, the time deduced from this and the approximate latitude will be a very close approach to the true sidereal time at the place. The

original latitude from the first observation may now be corrected by a more accurate knowledge of the time, and the azimuth of the star at the time of observation be deduced, whence the reading corresponding to the meridian position of the instrument is also known. If these observations have been managed with any skill or discretion, the latitude and time are now found near enough for future calculations.*

To ascertain the latitude with the utmost precision, several standard stars are to be observed near the meridian, and, if it may be, at pretty nearly equal distances from the zenith, north and south, to 70° or 80° zenith distance. A few minutes before the star comes to the meridian, bisect it near the centre of the middle horizontal wire, noting the time of bisection. It is perhaps more exact to place the wire close to the star, and then, leaving the vertical circle untouched, to move the whole instrument by the horizontal clamp along with the star, until it is bisected upon the wire by its own motion. The ends of the level and the upper microscopes are then read, the instrument is turned gently round 180° in azimuth, and the observation is repeated. The sum of the two angles (when each pair of readings is connected into one zenith distance) is twice the apparent meridian distance of the star, affected by the want of verticality in the axis, which is known from the level, and by a small correction depending on the time of observation. It is clear, that if the end of the level towards the eye end of the telescope is too high, the foot-screw towards the observer should be lowered, in which case the telescope would point above the star, that is, show a less zenith distance than the true zenith distance. Hence the rule is, take the reading of the end of the level towards the object end of the telescope from the reading towards the eye end, halve the difference, and add this, when converted into arc, to the instrumental zenith distance. This may be done in each case, or the mean of the whole applied to the mean of the instrumental zenith distance. For the *correction to the meridian* the formula is,

$$\text{Corr.} = \frac{\text{cos. dec. } * \times \text{cos. lat.}}{\text{sin. zen. dist. } *} \times \frac{2 \text{ sin.}^2 \frac{1}{2} \text{ angle at the Pole}}{\text{sin. } 1''}$$

The first factor must be computed for each star; the latter is taken from a table which may be found in *Schumacher's Hülfstafeln*, or *Baily's Tables*, and in many collections of astronomical tables. The argument is the angle at the pole, that is, the difference between the moment of observation and the transit of the star. This correction is to be *subtracted* from the zenith distance of stars observed *above* the pole, and *added* to those observed *below* the pole. The mode of observing is generally known by the name of *circum-meridian*. We have here detailed the process as it refers to a single pair of observations, but several pairs may be taken, as many as can without hurry be got in a quarter of an hour on each side of the meridian. With a good instrument and a careful observer, the latitude thus deduced from several stars will be very near the truth, if the observer employs a correct catalogue, such, for instance, as that of 1112 northern stars, published by Mr. Pond in 1833, or the catalogue of southern stars, by Lieut. Johnson, 1835: if he can observe the same circumpolar stars at their upper and lower culminations, he may obtain a latitude independently of any catalogue. If stars near the pole be observed, it is not necessary that they should be near the time of passing the meridian, but the reduction to the meridian zenith distance must be computed by an exact formula. There are special tables of Polaris for this purpose in the *Nautical Almanac*.

The time may be found by two or three methods. The zenith distances of known stars near the prime vertical, both to the east and west, may be observed, and the horary angle computed from the observed zenith distance and the known colatitude already found. In this case the altitude circle should be kept clamped, while the times of the passage of the star over each of the horizontal wires are noted, the mean is to be taken, and the instrumental zenith distance is to be corrected for the indication of the fixed level. Repeat the operation after reversing the instrument, and take the mean of the zenith distances, which will correspond very nearly with the middle time between the observations. From this zenith distance the error of the time-keeper is found. The mean of the errors deduced from an equal number of stars on the east and on the west prime vertical will be very nearly correct, and depend upon the divisions of the circle and the catalogue employed. Also, the altitude circle being clamped, a star may be observed rising near the east prime vertical, and again, by moving the instrument in azimuth, near the west prime vertical when descending. The middle time will be the meridian passage of the star by the time-keeper, which, when compared with the computed right ascension, will show the error of the time-keeper. This method (commonly called that of *equal altitudes*) is not to be recommended, except for stars near the zenith, which pass quickly from one prime

* Let S be the first star observed near the meridian, and σ the second near the prime vertical, P the pole, and Z the zenith; then PZ the colatitude = PS — ZS nearly. Again, the triangle PZσ being solved with this approximate value of PZ will give the angle σPZ, which, if the star is west, being added to, or if east, being subtracted from its right ascension computed from the catalogued place, gives the true sidereal time at the place of observation, and hence the error and correction of the time-keeper. Let this correction be applied to the time of observing S, then the difference between the time so corrected and the computed right ascension of S gives the $\angle$ SPZ, from which the correction of ZS to the meridian may be deduced.

vertical to the other. The changes of the level, of the instrument, or of the time-keeper, may occasion greater errors than can well arise from the divisions of the circle, not to mention the greater length of time occupied by the observation, and the chance of disappointment from change of weather. Lastly, the time may be derived from this instrument, when the lower circle is clamped, and the telescope is made to move in the meridian like a transit. The transit will be explained hereafter, but the adjustment to the meridian is greatly facilitated in this instrument by the divided horizontal circle. Either the azimuths of a star may be observed when it has the same altitude on the east and west of the meridian, in which case the middle reading of the azimuths will be the reading corresponding to the meridian; or the time may be got very nearly from a star near the zenith, and then the error of the time-keeper being known, Polaris or any near circumpolar star, may be bisected, by moving the instrument in azimuth, at the time when, by the clock, it should be on the meridian; or Polaris, or any known circumpolar star, may be observed at its greatest elongation, when its azimuth is known by computation; or, generally, a known circumpolar star may be observed anywhere, and its azimuth be computed for the *known* time of the observation, when the instrument can be shifted this quantity. For the mode of correcting errors of level, &c., and of deducing the longitude from the passage of the moon over the meridian, &c., see TRANSIT.

When the direction of the meridian is required with great accuracy, the process used in the 'Trigonometrical Survey,' vol. i. p. 242, may be followed. The azimuth of Polaris was observed when at its greatest elongation to the east and to the west of the meridian, and the mean of these was taken for the reading of the north point. The cross level should be applied to the transit axis and the error carefully noted before every observation, and the instrument should be reversed once at least during the series.

Little has been said of the *error of collimation in altitude*, because in truth the determination of this error is scarely ever required in a separate shape by an accurate observer. It may, however, be determined thus: Observe a star with the divided face of the circle to the east, and then with face west, near the meridian, exactly as has been already described, correct each zenith distance to the meridian and for the indication of the fixed level. Then the difference between these zenith distances, if any, shows that the microscopes do not read 0°, when the telescope is in the zenith and the vertical axis is correct: half the difference is to be added to all observations made with the instrument when the face is one way, and to be subtracted from all observations when the face is the other way, as the case may be.

If an observer should wish to use an instrument of this kind for making a catalogue of unknown stars, he may place it accurately in the meridian, and observe transits and zenith distances at once, using an index error for the latter, deduced from known or standard stars, as we have described above. Or the zenith distances may be determined by *circum-meridian* observations, which is perhaps a more accurate and certainly a more independent mode. The peculiar advantage of the altitude and azimuth circle is, however, for observing phenomena when out of the meridian, and therefore not within the reach of the principal instruments: for instance, in determining the place of a comet, &c. Here the time must be noted when the object is bisected by the crossing of the horizontal and vertical wires, and the upper and lower microscopes and fixed level read off. The instrument is now to be reversed and the operation repeated. Then if the object is not near the meridian and the interval is short, the mean of the zenith distances and the mean of the azimuthal readings correspond very nearly to the middle time, and as the azimuthal reading of the meridian is, or easily may be known, the azimuth and zenith distance of the object at a *given* time are known, which, with the colatitude, are two sides, and the included angle of the triangle Z P S, which can therefore be solved, and the polar distance P S, and the horary angle Z P S be found. If the observations should be made near the meridian, the corrections as found in circum-meridian observations must be applied.

The observer, who is not afraid of working spherical trigonometry, will find the following a very exact method of ascertaining the place of a comet or planet: Observe the altitude and azimuth, noting the time, of a known star, as near the comet as may be, and then the altitude and azimuth, also noting the time, of the comet. The *computed* altitude and azimuth of the star, when compared with that *observed*, will give an index error for the instrument, in altitude and in azimuth; which, when applied to the observed places of the comet, afford correct data for computing its horary angle and polar distance. This method is only an application of the principle of measuring differences, rather than absolute quantities, and admits of great exactness, even with an indifferent instrument, especially if several stars, on different sides of the comet, are used; but the labour is considerable.

An instrument of this kind will show very clearly the effects of refraction and parallax, though it cannot be expected to increase our knowledge on these points. On comparing the observed zenith distance with the zenith distance computed from the polar distance, and the horary or azimuthal angle, the difference will be the effect of refraction, or of refraction and parallax, as the case may be. The determination of the law and quantity of refraction was one of the purposes for which Piazzi's circle was principally designed.

The instrument-maker ought to mark the value of the parts on the

scales of the levels, but it is advisable to ascertain these independently. Place the instrument so that the third foot-screw, that with the slow motion apparatus, is in the plane of the altitude circle, raise the foot-screw till the end of the bubble towards the observer is near the end of the scale, bisect a well-defined object with the telescope, and read the upper microscopes and the ends of the bubble. Then lower the foot-screw till the bubble is towards the other end of the scale, bisect the object again, and read off the microscopes (bringing the crosses to the same divisions) and bubble as before. You have thus a given number of parts of the scale, those through which the bubble has travelled equal to the difference of the readings of the microscopes in the two positions, which is therefore known in seconds of spaces. This should be done several times, and the temperature noted, as it will be found that not only the length of the bubble, but the value of the parts, varies with the temperature. A table may then be made for future use. By attaching the cross level to the altitude circle it may be examined in the same way.

There are several variations in the form of the altitude and azimuth circle. The vertical axis is sometimes depressed below the azimuth circle, which gives the instrument a greater compactness of form. In a few instances, instead of a pair of microscopes upon a fixed support, there are three or more which can be placed anywhere on the circumference of a ring, parallel to and concentric with the vertical circle. This is a very essential improvement, as besides getting rid of eccentricity, three microscopes at 120° distance, or a pair at right angles, destroy the effect of any change of figure corresponding to ellipticity. (See 'Monthly Notices of the Astron. Soc.,' vol. ii. p. 96.) The errors of division may also be gradually eliminated by changing the positions of the readings. Three or more microscopes are sometimes applied to the horizontal circle.

The circle here drawn and described is divided by an engine; in instruments of higher pretensions one or both circles are divided by hand, generally according to Troughton's method. Sometimes both faces of the vertical circle are divided. There is a figure and description of a very beautiful circle, generally known by the name of the Westbury circle, in a paper by Mr. Pond, 'Phil. Trans.,' 1806, p. 420, plate xx., and of another in Pearson's 'Astronomy,' vol. ii .p. 434, plate xix. A vertical circle, of eight feet diameter, moving freely in azimuth, planned by Ramsden and finished by Berge, is at the Observatory of Dublin, which, so far as we know, has not yet been described, though well known by the deductions of Dr. Brinkley. (See 'Trans. Royal Irish Academy,' vol. xii. p. 33.)

The *transit circle* is very shortly described, as it is only the upper circle of the last-mentioned instrument, generally on a larger scale. This, when fixed in the plane of the meridian, may be used both as a transit and as a meridian circle at the same time. The supports should be of stone, to which the reading microscopes should also be attached. A very beautiful transit circle, of four feet diameter, and divided on both faces, was constructed by Mr. Troughton in 1804. This was for many years in the possession of the late Stephen Groombridge, Esq., of Blackheath, and was employed by him in forming a catalogue of stars within 50° of the north pole. It is described and engraved in Pearson's 'Astronomy,' vol. ii. p. 402, plate xvii. The artist himself was dissatisfied with the weakness of the axis, a capital fault in an instrument for observing transits; and we conceive that there was a still greater oversight, though one more easily repaired, in the unsteady fixing of the reading microscopes, which are mounted on slender bars of brass instead of stout stone crosses; the consequence was, that the index error was always changing. The meridian circle of Röemer, and those which resemble it, have been already mentioned. This form is perhaps preferable to that of Groombridge's, the axis being less subject to flexure; but its unsymmetrical appearance is disagreeable, and make some of the ordinary modes of adjustment impracticable. The unequal bearing on the pivots may also require caution. The meridian circle of Reichenbach is like the ordinary transit telescope, with the circle and verniers close to one of the pivots. It is too complicated to be described in a few words, and is not, we believe, to be met with in this country; but most of the Continental observatories east of the Rhine are furnished with them. In the hands of Bessel, Gauss, &c., the circle of Reichenbach is undoubtedly a very powerful and accurate instrument; but we think not so perfect, certainly not so fit for ordinary observers, as a closer copy of Roëmer's would be, while it is much less simple, and the telescope is more liable to injurious flexure.

The adjustments of the transit circle are those of a mural circle and of a transit combined. A very ingeniously contrived plumb-line was applied to Groombridge's circle, to level the cross axis and adjust the collimation in altitude; but the methods alraady described were found to be more accurate and much less troublesome. Indeed, the plumb-line apparatus of the mural circle is superseded by the use of observations by reflection.

* In 1851 the mural circle and transit instrument of the Royal Obsertory, Greenwich, were replaced by a transit circle, the design of which is due to Mr. Airy, the present astronomer-royal. This fine instrument was constructed by Messrs. Ransome and May, of Ipswich, and Mr. Simms, of London. The telescope has an aperture of 8 inches, and a

* This paragraph and the one which follows has been added to the original article by the Rev. Richard Sheepshanks.

focal length of 11½ feet. The circle is 6 feet in diameter. The divisions are read off by means of six microscopes firmly imbedded in stone piers. The material used in the construction of the instrument is cast-iron. A similar instrument has been subsequently made by Mr. Simms, for the Royal Observatory at the Cape of Good Hope. The transit-circle used by Mr. Carrington in the observation of the stars for his Redhill catalogue, has also been constructed upon the plan of the Greenwich instrument.

An altitude and azimuth circle has been recently introduced at the Royal Observatory, Greenwich, for the special purpose of observing the moon when she is out of the meridian. Two distinct circumstances suggested the expediency of this step. In the first place it frequently happens, that when the moon is on the meridian she is concealed from observation by the unfavourable state of the weather; secondly, the moon cannot be seen on the meridian for several days before and after conjunction, by reason of the overpowering effulgence of the sun's rays. By means of the altitude and azimuth-circle, or the altazimuth as it has been called, this inconvenience has been effectually obviated, the number of extra-meridional observations being about twice as great as the number of observations made when the moon is on the meridian. The altazimuth was designed by Mr. Airy, and constructed by Messrs. Ransome and May of Ipswich, and Mr. Simms of London. The vertical and azimuthal circles are each 3 feet in diameter. The telescope is furnished with an object-glass of 3¾ inches aperture. The observations with this instrument were commenced on the 16th of May, 1847. A remarkable illustration of their utility in contributing towards the improvement of the lunar theory, has been recently afforded by a comparison of the meridional and extra-meridional observations of the moon made at the Royal Observatory, Greenwich, in the year 1852, with the corresponding results of 'Burckhardt's and Hansen's Lunar Tables.' ('Monthly Notices, R. Ast. Soc.' vol. xix. p. 211, *et seq.*) The agreement of the observed places of the moon with Hansen's Tables' (in the preparation of which the extra-meridional observations of the moon were used) leaves nothing to be desired.

Besides the works we have already referred to, the astronomical reader may consult, as to the mural circle, Pond's 'Observations,' 1812, p. 236, and 1825 (where an example is fully worked out), for an account of his two methods, and his memoirs in the 'Phil. Trans.' and 'Memoirs of the Astronomical Society;' 'Cambridge Observations,' vols. vi. and vii., and Johnson's 'Catalogue of Southern Stars,' 1835. For the transit circle, Wollaston's 'Fasciculus,' preface and appendix. For the altitude and azimuth circle, a paper by Mr. Troughton, 'Memoirs of the Astron. Society,' vol. i. p. 33; and generally, the article 'Circle' of the 'Edinburgh Cyclopædia,' by Mr. Troughton, and Dr. Pearson's 'Practical Astronomy.' On the mode of dividing circles and the errors to which their divisions are liable, see GRADUATION, and Troughton 'Memoir, Phil. Trans.,' 1809, p. 105; Dr. Robinson's Paper, already cited, and another by the same author, 'Memoirs of the Irish Academy,' 1825; two Papers in the 'Memoirs of the Astron. Society,' on the 'Errors of the Cape Circle,' one by Mr. Sheepshanks and Professor Airy, vol. v. p. 320; the other by Mr. Henderson, vol. viii. p. 141.

CIRCLE, MURAL. [CIRCLE, ASTRONOMICAL.]

CIRCLE, QUADRATURE OF THE. [QUADRATURE.]

CIRCLE, REFLECTING. [SEXTANT.]

CIRCLE, REPEATING. [REPEATING CIRCLE.]

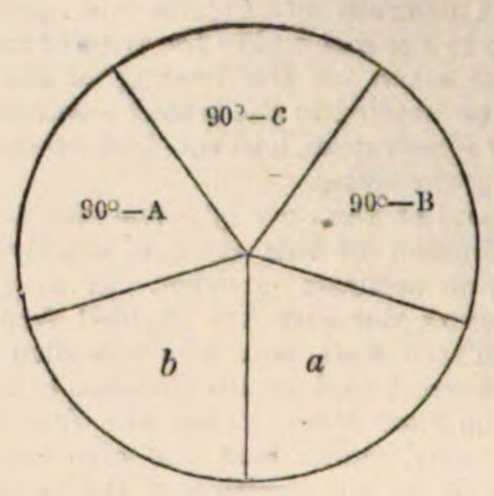
CIRCLE, TRANSIT. [CIRCLE, ASTRONOMICAL.]

CIRCLES OF DECLINATION, ALTITUDE, &c. The use of these terms is not very well settled. According to some, a circle of declination would mean the parallel of any declination, or the small circle all whose points have the same declination; that is, a parallel to the equator. According to others, it would mean the circle on which declination is measured, that is, an *horary* circle passing through the poles. And the same of the other circles. Perhaps the latter sense is the more generally used; but in all cases the student must be aware of the difference when he consults a book on the doctrine of the sphere.

CIRCUITS, in English law, denote the periodical progresses of the judges of the superior courts of common law through the several counties of England and Wales, for the purpose of administering civil and criminal justice. The ordinary circuits take place in the spring and summer of each year; and for several years past the judges have made winter circuits through the principal counties in the month of December, for the trial of criminals. In 1858, the experiment of a Winter Assize for civil business was tried at Liverpool. All the circuits take place under the authority of several commissions under the great seal, issued to the judges and others associated with them on each occasion. [ASSIZE.] Most barristers practising in the common law courts in London are attached to one or other of the circuits; and each circuit is constantly attended by a numerous bar. The transaction of judicial business in the presence of a professional audience of this kind, has been justly considered as one of the best securities for the due administration of justice; and in consequence of the system of circuits, this advantage is not confined to the metropolis, but is communicated to the most remote parts of the kingdom.

Since the statute 11 Geo. IV. and 1 Will. IV. c. 70, by which the ancient system of Welsh judicature was abolished, the circuits of the judges are eight in number, and the counties of England and Wales are distributed among them in the following manner: The Northern Circuit comprehends the counties of York, Durham, Northumberland, Cumberland, Westmoreland, and Lancaster; the Western Circuit comprehends the counties of Southampton, Wilts, Dorset, Devon, Cornwall, and Somerset,—and Bristol; the Oxford Circuit comprehends the counties of Berks, Oxford, Worcester, Stafford, Salop, Hereford, Monmouth, and Gloucester; the Midland Circuit comprehends the counties of Northampton, Rutland, Lincoln, Nottingham, Derby, Leicester, and Warwick; the Home Circuit comprehends the counties of Hertford, Essex, Kent, Sussex, and Surrey; the Norfolk Circuit comprehends the counties of Buckingham, Bedford, Huntingdon, Cambridge with the Isle of Ely, Norfolk, and Suffolk; the South Wales Circuit comprehends the counties of Glamorgan, Carmarthen, Pembroke, Cardigan, Brecon, Radnor, and Chester; the North Wales Circuit comprehends the counties of Montgomery, Merioneth, Carnarvon, Anglesey, Denbigh, Flint, and Chester.

CIRCULAR PARTS (NAPIER'S). A proposition which generalises the relations between the parts of a spherical right-angled triangle into two only; first given (with a demonstration) by Napier in his 'Mirifici Logarithmorum Canonis Descriptio' (ch. iv. 1-8). It is as follows: Let a and b be the sides, c the hypotenuse, and A and B the angles opposite a and b, in a right-angled spherical triangle. Then take the complements of the hypotenuse and of the two angles, and the two sides, and write them in order in a perpetually recurring series, or round a circle, as follows:—



Then taking any three parts, one may be made the *middle* part, and the other two either *adjacent* extremes, or *opposite* extremes. Thus 90°—B being the middle part, a and 90°—C are its adjacent extremes, and b and 90°—A its opposite extremes. Napier's rules are

1. Sine of *middle* = product of tangents of *adjacents*.
2. Sine of *middle* = product of cosines of *extremes*.

Thus sin. b = tan. a tan. (90°—A)

= cos. (90°—B) cos. (90°—c).

But we should strongly recommend the student to have nothing to do with this artificial memory, for it involves a process upon every occasion; and while one person is learning which are the parts, which have complements taken, and the rules, another will master the six results, and will have no occasion for any future process. These results are

1. Cosine of hyp. = product of cosines of sides.
2. Cosine of hyp. = product of cotangents of angles.

3. Sine of *side* = sine of hyp. × sin. *opposite* angle.
4. Tang. of *side* = tang. of hyp. × cos. *adjacent* angle.

5. Tang. of *side* = tang. *opposite* angle × sine of other side.
6. Cos. of *angle* = cos. of *opposite* side × sin other angle.

These pairs present analogies which will help the memory, and we should recommend them in preference to the rules of circular parts.

CIRCULAR POLARIZATION. [ROTATORY POLARIZATION.]

CIRCULATING DECIMALS. When a common fraction cannot be expressed exactly as a decimal, the attempt leads to a never-ending series of figures, any number of which, with the decimal point properly placed, is an approximation to the common fraction, and the more near the greater the number of figures taken. Thus 1 with ciphers affixed and divided by 7, leads to the recurring or circulating series

$$142857142857142857\ldots\ldots$$

and ·1428 is nearly $\frac{1}{7}$, but ·14285714 much more nearly. Hence it is said that $\frac{1}{7}$ is a circulating decimal whose period is 142857, and is denoted by $\cdot\dot{1}42857\dot{}$. Similarly $\cdot12\dot{9}$ denotes ·129999 .... and $\cdot0\ddot{5}3\ddot{6}$ denotes ·053636 .... As a part of fractional arithmetic, the rules for converting these fractions into common fractions are useless, though found in most elementary works. One example will be sufficient here.

$$\cdot14\dot{3}6\dot{2} = \cdot14362362, \text{ \&c.} = \cdot14 + \tfrac{1}{100} \times \cdot362362\ldots$$

If the circulating part continued *ad infinitum* be called S, it is plain that $1000\,S = 362 + S$, or $S = \frac{362}{999}$, whence

$$\cdot 14\dot{3}6\dot{2} = \frac{14}{100} + \frac{362}{99900} = \frac{14 \times 999 + 362}{99900}$$

Wallis ('Algebra,' ch. 89), Euler ('Algebra,' ch. 12, book i.), and John Bernoulli the second ('Mem. Acad. Sci.,' 1771), have treated this subject. We shall merely state some theorems to show the remarkable character of the periods.

1. Form the period of a prime number m; its number of figures will be either $m-1$ or one of its divisors. The period of 7 (being 142857) has six figures; that of 13 (being 769230) has 6, the half of $13-1$ figures.

2. When the period of a prime number m contains $m-1$ figures, the last half may be formed from the first by taking each figure in the first from 9. Thus the first and second halves of the period belonging to 47 are—

First half 02127659574468085106382
Second half 97872340425531914893617

3. When the period of a prime number m has $m-1$ figures, multiplication by any number under m only changes the order of the figures. Thus the period of 7 being 142857, we have here a number which, being multiplied by 2, becomes 285714; by 3, 428571; by 4, 571428; by 5, 714285; and by 6, 857142.

The following work may be useful to those who are curious on the subject: 'A Table of the Circles arising from the division of a Unit, or any other whole number, by all the integers from 1 to 1024, being all the pure decimal quotients that can arise from this source.' London, Richardson, 1823.

CIRCUMCISION, the operation of cutting off the prepuce or foreskin, is sometimes performed for a medical purpose; but it is general or universal among some nations as a religious rite, and among others as a national custom. The practice of circumcision appears to be of the highest antiquity. Abraham, as recorded in Genesis (xvii. 10-14), by the command of God, circumcised himself and all the males of his household; though circumcision is not there mentioned as being a novelty, nor are any directions there given for the manner of performing the ceremony. Abraham himself was ninety-nine years old (Gen. xvii. 24) when he was circumcised. The rite of circumcision was ordained to be an everlasting covenant between God and the seed of Abraham; and it was declared that "the uncircumcised man-child whose flesh of his foreskin is uncircumcised, that soul shall be cut off from his people; he hath broken my covenant." All the males that left Egypt were circumcised, but during the forty years' wandering in the wilderness the rite was not performed. Joshua, by the express command of God, renewed it by circumcising all the males just after the passage of the Jordan. (Joshua v.) Ever since the circumcision by Joshua, it has been universally observed, both among the Jews and the Ishmaelitish descendants of Abraham. Circumcision is not, properly speaking, a rite of the Mohammedan religion; it is not enjoined in the Koran, but the Arabs, and Mohammed himself, were circumcised before the religion of the Koran began to be preached, and their descendants have continued the usage as one which had always prevailed among them, and have also communicated it to the Saracens, the Turks, and the other nations who have become associated with them in a common faith. In point of fact, circumcision is as universal among the Mohammedans as it is among the Jews.

A great deal has been written, both on the ceremonial of the Jewish circumcision, and on the question as to the sacramentary efficacy which has been sometimes attributed to the rite. On these matters the reader may consult Burder's 'Oriental Literature,' Calmet's 'Dictionary of the Bible,' Simon's 'Dictionary of the Bible,' and especially the able dissertation on circumcision in Michaelis's 'Commentaries on the Laws of Moses,' book iv. chap. iii. part i., the English translation by Dr. Smith, 4 vols. 8vo, 1814, and the authorities there referred to. Michaelis is decidedly of opinion that circumcision was never intended as a sacrament. Among the ancient Jews, not only all proselytes were circumcised, but also all bondmen or slaves, and their children. (Gen. xvii. 12, 13.)

The prevalence of circumcision among various ancient nations is mentioned by Herodotus (ii. 36, 37, 104), by Diodorus Siculus (i. 26 and 55, iii. 32), and others. Herodotus says that the Colchi, the Egyptians, and the Ethiopians, were the only nations who had practised the custom from time immemorial, and that the Phœnicians and the Syrians of Palestine (the Jews) admitted that they had acquired the custom from the Egyptians. This notion, that the Jews had learned circumcision from the Egyptians, has been taken up and maintained in modern times by Sir John Marsham in his 'Chronicus Canon Ægyptiacus,' by Jahn, and others. (See De Pauw's 'Recherches Philosophiques sur les Americains.') But supposing this opinion to be false, it does not follow, on the other hand, as has been contended by some, that all other nations among whom the custom prevails must have derived it from the Jews. It has been supposed by some critics (but in our opinion without good reason), that among the ancient Egyptians it was only the priests, and those who desired to study the sciences of which they were the teachers, who were obliged to be circumcised. See the notes of Wesseling and Larcher on the passages of Herodotus above referred to, the Commentary of Origen on the 'Epistle to the Romans,' ch. ii. v. 13, and a curious note of M. Huet on Origen's Commentary on Genesis. (Origenis Opera, à Car. de la Rue, 4 vols. fol., Par., 1733, &c., vol. ii.) It is said that Pythagoras submitted to the operation of circumcision in order to obtain instruction in the secret doctrines of the Egyptian priests.

Strabo (book xvii. 824) says by mistake that the Jews practised excision on their female children; but, although this never was a custom of the Jews, it has prevailed, and still does, among other nations, particularly the Abyssinians, Nubians, and the modern Egyptians. See Ludolphi, 'Hist. Æthiopica;' Niebuhr's 'Description de l'Arabie;' Sonnini's 'Travels in Egypt,' 'Description de l'Egypte;' and Browne's 'Travels in Africa, Egypt, and Syria.' The practice seems to have extended from south to north, and to have included Ethiopia, Egypt, Judæa, Phœnicia, Syria, Cappadocia, the Macrones, and the Colchians.

It is remarkable that circumcision has been found to prevail, and in some cases the excision of females also, among various savage or imperfectly civilised races. It is said that the rite was practised by the Mexicans when the Spaniards first became acquainted with them. Cook found an imperfect species of circumcision, consisting of the splitting of the prepuce, in use among the natives of the Friendly Islands. (Kerr's 'Voyages,' vol. xiii.) Long before, many of the old voyagers had met with it among the islands of the Indian Archipelago, among the tribes of the west coast of Africa, and elsewhere. In Purchas's 'Collection,' Edmund Scot gives a long account of the ceremonial of the circumcision of the king of Bantam in Java, at which he was present, in 1605. Captain William Keeling, in 1608, states that he found the people at the bay of St. Augustine, on the west coast of Africa, circumcised; and Captain Richard Jobson describes the ceremony, as he witnessed it at Batto, on the same coast, in 1621. An abstract of these and other early accounts may be found in Prevost's 'Histoire Générale des Voyages.' See the same work for a description of the ceremony of circumcision as practised among the people of Madagascar. Dampier, in his graphic manner, describes the mode of circumcision as he witnessed it performed in 1686 at the Philippine Islands. ('Voyages.') An account of what he calls the circumcision of females as well as of males by some of the African tribes, is given by Bosman, in his 'Description of the Coast of Guinea,' English translation; and it has been more recently ascertained to have long existed among some of the Indians in South America, among the inhabitants of Tahiti, and those of the Fiji islands. The principal distinction between circumcision as practised by the Jews and by other nations, is that the former, in obedience to the terms of the command given to Abraham, always when it is practicable circumcise the child on the eighth day after its birth; whereas, among other nations it is usually deferred to a much later period. Among the Mohammedans it is commonly performed in the thirteenth year, because Ishmael, the progenitor of the Arabs, was of that age when he underwent the operation. (Gen. xvii. 25.) By some it has been contended that this operation has been adopted from a notion that it was conducive to health in hot climates.

Kolben, in his 'Present State of the Cape of Good Hope' (translated by Medley), gives an account of a very singular custom of the Hottentots, which he conjectures may have been derived from the Jewish circumcision; and see Winer's 'Biblisches Realwörterbuch,' article 'Beschneidung,' Leipzig, 1847.

CIRCUMFERENCE (*circum* and *fero*), the line which goes round a figure. We do not know why, but this word is always applied to a curvilinear figure; while the synonymous Greek word periphery (*περί*, *φέρω*) is used for a rectilinear figure.

CIRCUMFERENTOR. This instrument is a species of surveying-compass, and its construction may be understood from a view of the diagram in the article SPIRIT LEVEL, since, if the reader will imagine the telescope of that instrument to be removed, and, for the supports, called Y.s, sight-vanes or perforated plates to be substituted, the instrument will be a complete circumferentor.

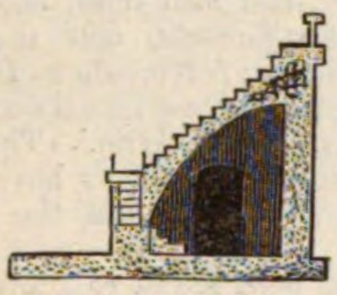
Such an instrnment being far inferior to a theodolite in respect of the accuracy with which by its means a survey may be made, is not much used in Europe; but in the United States of America and in the British colonies, where land is less valuable, it is, or was till lately, almost the only instrument employed.

In using the circumferentor for the survey of a line of road, or the determination of the boundary of a tract of land, the instrument is set up, on its stand, successively at the principal bends of the road or boundary line; and a staff being held up vertically at the next bend which is visible from the place of the instrument, the sights of the latter are directed to it; then the bearing of each station-line from the needle in the compass-box, that is, from the magnetic meridian, is observed. Each station-line is measured by the chain, and the smaller bends of the road or boundary are determined by "offsets" measured perpendicularly to that line. [COMPASS, AZIMUTH; SURVEYING.]

CIRCUMFLEX. [ACCENT.]

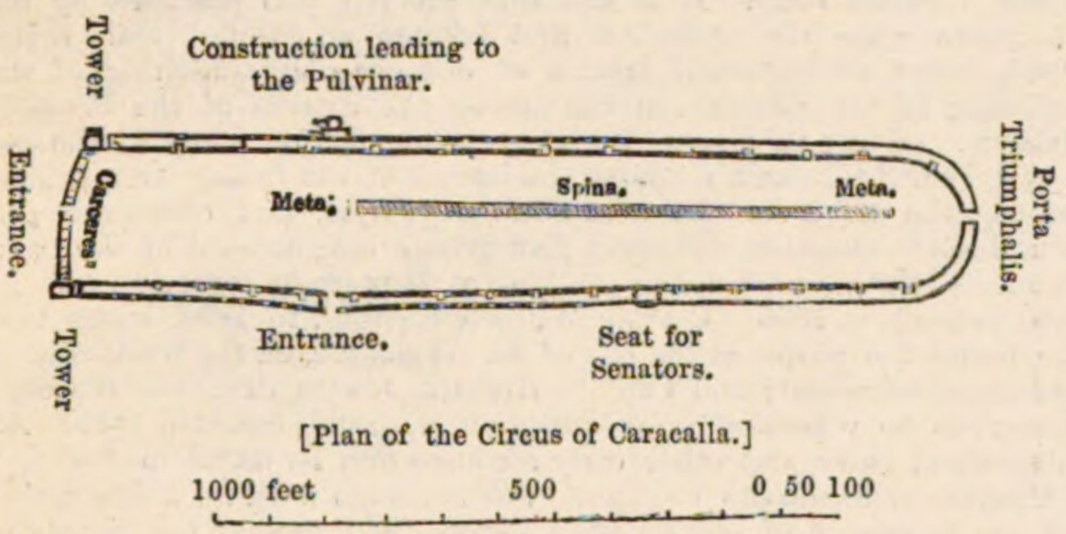
CIRCUS, a large enclosed space, adapted for chariot-races, an amusement to which the Romans were passionately attached. The name Circus (of which circulus, a *circle*, is a diminutive) does not convey an

exact idea of the form of this building, which both in its outline and its use very much resembled the Greek Stadium. There were many circi in Rome, of which the Circus Maximus and the Circus Agonalis were perhaps the largest. The former may still be distinctly traced; the latter retains its external form only in the Piazza Navona of Rome. The Circus Aurelianus, or, according to some, of Heliogabalus, stood near the Amphitheatrum Castrense. The ruins of the Flaminian Circus are hid beneath the pavement of the city. The Circus of Nero was begun by Caligula; part of its site is now occupied by the Basilica of St. Peter. This circus is said to have been longer than the cathedral



Section of Seats.

Amphora used in constructing the arch.



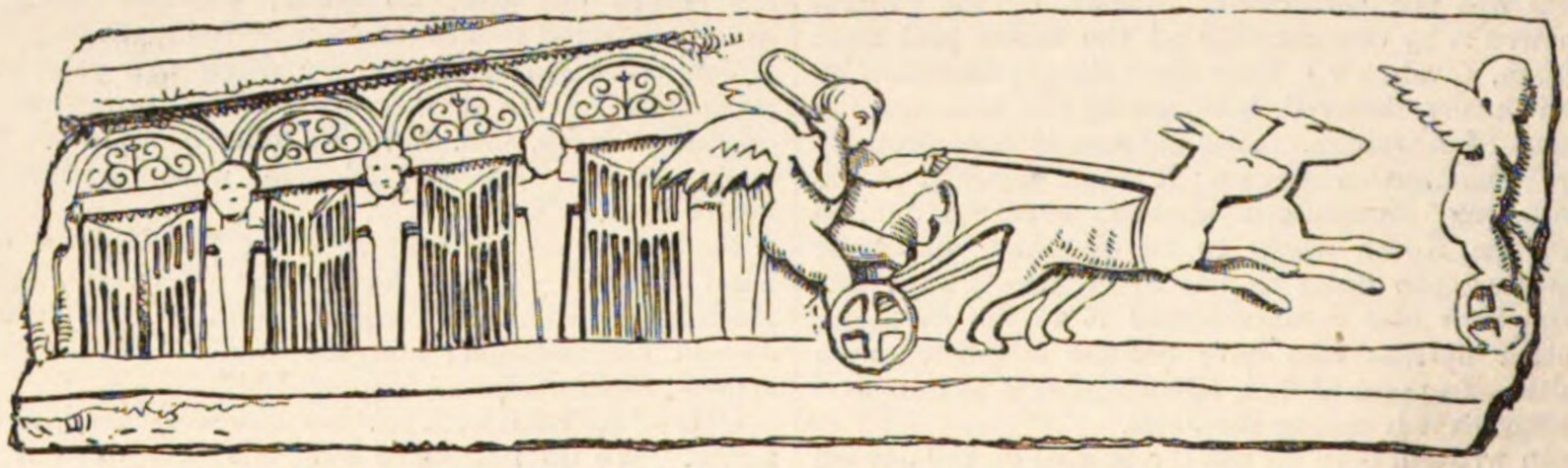
[Plan of the Circus of Caracalla.]

Bianconi makes the Circus of Caracalla 255 French toises long, and 50 toises wide; the spina 142 toises long, and the start from the carceres to the spina 79 toises. The widths of the openings between the spina and the walls of the circus are 21·3 toises at the first goal, 19·3 at the second goal, 17 toises at the turn on the other side of the second goal, and 15·4 toises at the final goal. The width of the vaulting is 4 toises. (A toise is about 6·396 English feet.)

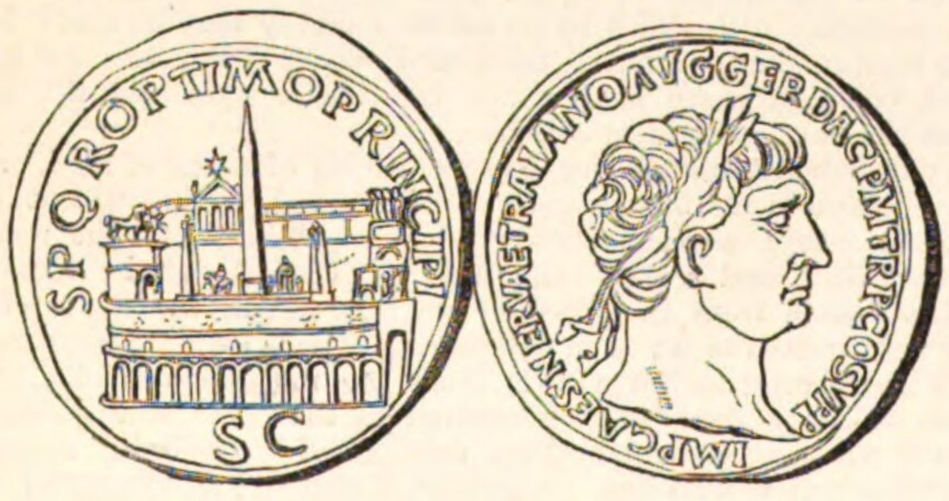
and colonnade in front. (Fontana's 'Tempio Vaticano,' p. 245.) Another circus, begun by Nero and finished by Hadrian, was situated in the gardens of Domitian, near the Mausoleum of Hadrian. Several antiquities and paintings were discovered here some years ago. In the Gardens of Sallust there was a fine circus, which was also adapted for the exhibition of naumachiæ. The Circus of Flora was on the Quirinal Hill. There is a circus, not far from the Appian Way, near the tomb of Cæcilia Metella, about two miles from Rome, in a high state of preservation. It is probably of a later date than many of those which were constructed within the city; and perhaps to the circumstance of its being at a distance from the city walls, its present state of preservation may principally be owing. Antiquaries have called it the Circus of Caracalla, although no proof, we believe, has been discovered from inscriptions that this is the circus built by, and commemorated on the coins of, that emperor.

The Circus of Caracalla, of which we have given a plan and a section of the seats, may be considered a perfect model of this kind of building, both in judicious arrangement and ingenious construction. The long sides are not quite parallel: one end is semicircular, and the carceres at the opposite end, from which the chariots started, are formed on a segment of a circle, the chord of which is inclined to the long sides of the circus. The spina or raised division, which runs along the middle of the circus, is a kind of podium or basement, in appearance like a thick dwarf wall. It is not exactly parallel to either side of the circus. Of the carceres, which are twelve in number, six are placed on each side of the entrance which was intended for the use of the processions, and are so disposed, by the inclination of the chord line of the segment on which they may be said to be set off, that the starting of the twelve chariots was equalised. The carceres were most probably covered; they were also divided by partition walls with terminal figures in front of them, and arched over, with a cornice above the arches: the semicircular opening was filled with a window frame of marble, highly enriched; and they were closed with gates, most probably of bronze. A very tolerable idea of the architectural appearance of a circus may be formed from the inspection of a bas-relief in the British Museum.

There is also a representation of a marble fragment in Bianconi's work on this circus, in which men are seen opening the bronze gates, in order, as we may judge from their hurried action, to let out the chariots at the given signal. The spina, which was rounded at the two extremities, was decorated with metæ, or goals, each formed of three long cones: these cones are represented in the cut of a chariot race in the article Chariot, col. 759. Conical bells, called from their shape eggs (*ova*), were placed on the apex of each cone, and served to number the rounds which had been run. Dolphins were also employed for this purpose; these cones were sometimes gilt. In the basement of the cones in the Circus of Caracalla there is a small chamber formed; and the basements are separated from the spina. In the centre of the spina there was sometimes one of those enormous obelisks which were brought by the emperors from Egypt. Previous to the time of Augustus, a long pole occupied the centre. Small temples, statues



columns with statues on their summits, and altars, adorned the intermediate spaces between the centre and the goals; so that the spina must have presented a highly decorated and very pleasing appearance. The Porta Triumphalis, or gate by which the victor left the circus, was at the end opposite to the carceres. It is not improbable that the pulvinar, or emperor's seat, which in the Circus of Caracalla was a loggia with columns, was constructed at that part of the circus where the emperor, being near the carceres, would have the best view of the start and of the arrival at the goal. At the ends of the carceres of the Circus of Caracalla were two towers, in one of which was a staircase leading to the roofs of the carceres. The people occupied the stone seats along the sides and at the semicircular end of the circus. The Euripus, a canal ten feet wide and ten deep, was formed as a protection to the spectators, when they were not separated from the open space by a high podium or basement. The Circus of Caracalla has the podium and no Euripus. Some notion of the appearance of the circi may be collected from the medals of Caracalla and Trajan. In these



Coin of Trajan.

British Museum. Actual size. Bronze. 414¾ grains.

Coin of Caracalla.

British Museum. Actual size. Bronze. 469 grains.

medals the metæ and the quadrigæ are discernible, and the obelisk in the centre of the spina.

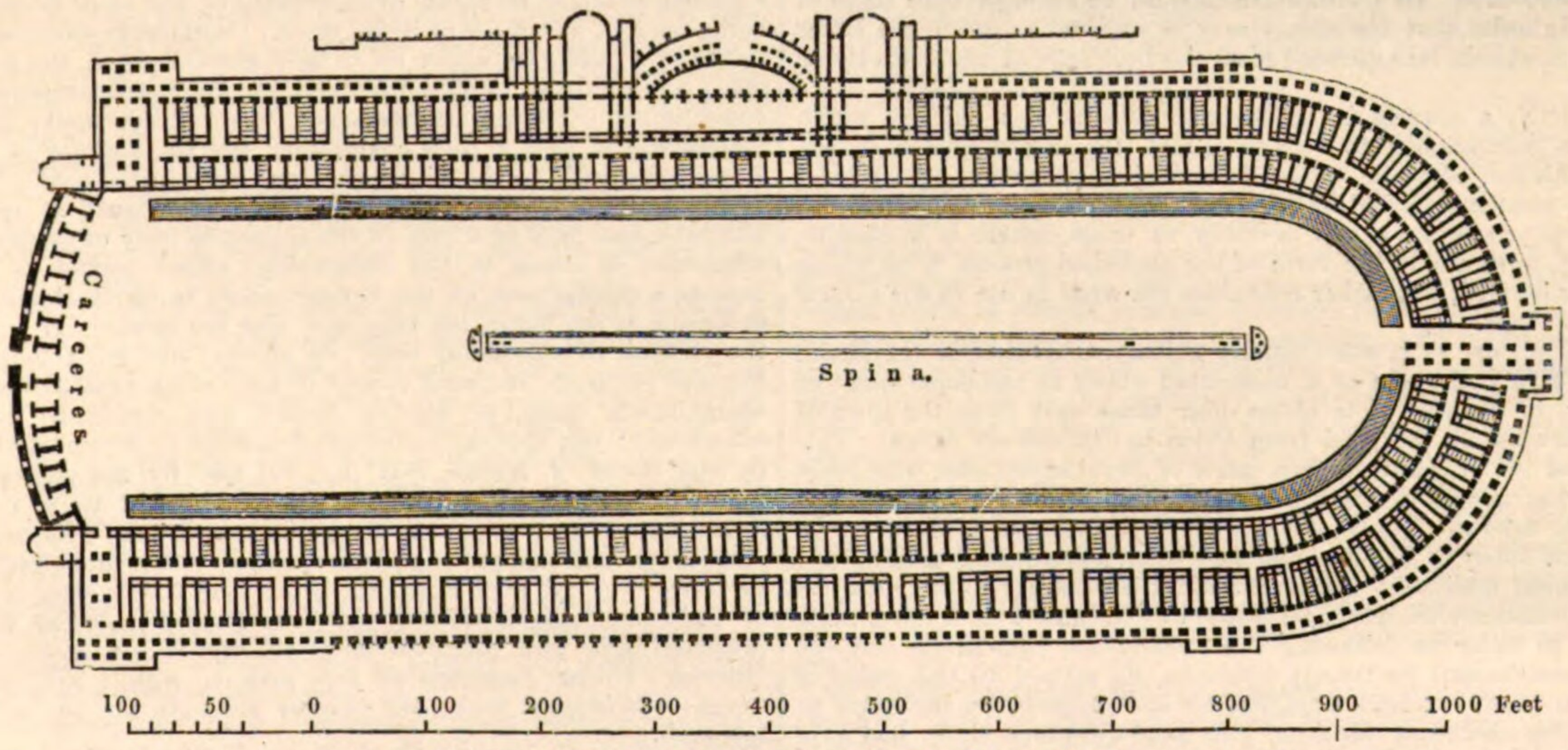
In order to lighten the weight of the materials used in the construction of the arch which supports the seats of the Circus of Caracalla, large amphoræ have been employed in the crown of the arch. Under this archway the people passed to the various openings with steps which led to the seats. The archway formed one great vomitorium. Although there were twelve carceres, the number of chariots varied; in a representation of a chariot-race on a sepulchral monument at Foligno, nine are represented.

The Circus Maximus, which was situated in a valley between the Palatine and Aventine hills, was very similar in form to that of Caracalla. According to Venuti, it was 210 French toises long by 85 wide,—that is, 1343·160 feet by 543·2; but other authorities have made the dimensions much greater. To Tarquinius Priscus tradition assigned the first building of a circus, on the site of which the Circus Maximus was afterwards erected. If ever there was a Circus of Tarquin, it may have been rebuilt after the destruction of the city by the Gauls. This edifice, whatever may have been its origin, was enlarged by Cæsar, and embellished by Augustus and Tiberius. In the time of Nero it was burnt down (Tacit., 'Annal.,' xv. 35); Trajan repaired it; and under Antoninus it became partially ruined, but was afterwards restored. The exterior of the circus, except at the carceres, consisted of two stories, adorned with columns, and finished with a terrace. The ground floor was occupied by merchants, except on the days appointed for the games. There were four towers more in the Circus Maximus than in that of Caracalla; one in the centre over the carceres (equidistant from those at each end of the carceres), one over the principal entrance, and one at each end of the semicircle, where it joined the straight sides of the circus: these towers were crowned with quadrigæ. The spina, which was rather more than 8 feet high and 12 broad, was decorated with temples in miniature, statues, and obelisks. Augustus brought an obelisk from Egypt, 126 feet high, and placed it in this circus; Constantius also erected in the circus the obelisk now called the Lateran, which is the largest of all the Roman obelisks.

There are traces of a circus at Tarragona, at Merida, at Murviedro (the ancient Saguntum), all in Spain; also at Nismes, Milan, Antioch, at Constantinople, and other places.

The games, which derived their name, *ludi Circenses*, from the circumstance that, after the time of Tarquinius, they were celebrated in the circus, were, according to tradition, instituted by Romulus under the name of Consualia (Livius, i. 9), in honour of the god Consus (or Neptune). They were exhibited on various occasions and for various purposes; sometimes, for example, by magistrates and sometimes by private citizens; either as rejoicings for success in war, or to avert the anger of some god. A grand procession from the capitol to the circus opened the games, and the images of the gods were taken along in carriages (*thensæ*). The combatants, dancers, musicians, and others followed, and last of all the consuls and priests advanced to perform the sacred rites. The exhibition consisted chiefly of chariot and horse races. The charioteers were divided into four classes, distinguished by the colour of their dress; one was white, another red, another sky-coloured, and another green. Domitian added two more, the golden and the purple. The favour of the people to one class or another was determined quite as much by the dress as by the skill displayed. Serious consequences often followed the disputes on the superiority of one colour above another. The order in which the chariots stood was determined by lot; and the signal for starting was given by dropping a cloth (*mappa*, or *pannus*). The chariot which first ran seven times round the course was victorious; and the driver, after being proclaimed by the herald, was crowned with a palm-wreath, and received a considerable sum of money. There were usually twenty-five such heats in the course of a day. Contests in the five exercises (*quinquertium*, the Greek πένταθλον), running, leaping, boxing, wrestling, and throwing the discus, also formed part of the exhibition. Wrestlers were anointed with ointment by slaves; boxers used gloves strengthened with lead or iron to give force to their blows; all underwent a preparatory training and dieting. These exercises were performed by the combatants almost entirely naked, and hence were called sometimes *certamen gymnicum*; the combatants had only a slight covering round the middle. A mock fight, called *ludus Trojæ*, was performed by young noblemen on horseback, an exhibition which was revived by Julius Cæsar. (Virgil, 'Æn.,' v. 561.) A sea-fight (*naumachia*) was sometimes represented: Domitian afterwards built a sea-fight theatre. (Suetonius, 'Domit.,' c. 5.)

The exhibition of the wild beasts (*venatio*) was one of the most attractive parts of their public entertainments. Wild beasts fought either with one another or with men; and the men were either forced to this combat as a punishment, or were induced to enter it by hire. Great expense was incurred to provide beasts for this exhibition, and



[Scale for the Circus Maximus, according to Venuti's plan.]

they were collected from the most remote parts of the empire. In the days of imperial splendour and profusion, the public exhibitions of Rome contained nearly every rare wild animal that western Asia and northern Africa could produce. The beasts were kept in inclosures (*vivaria*) till the time appointed for the show. The exhibitor of the games (*editor spectaculorum*) presided on a seat (*pulvinar*) at the south side of the building. So passionately fond were the people of these games, that the expression *Panem et Circenses* ("Bread and the Circensian Games") was commonly used to signify the two prime necessaries of life to the Roman populace. The crowds brought together by the games naturally attracted such persons as conjurers, jugglers, and fortune-tellers to the place, which is hence called by Horace (Sat. i. 6, 113), *fallax*, "deceitful." The splendour of the exhibition increased in the later times of the republic. P. Cornelius Scipio and P. Lentulus once exhibited 63 panthers and 40 bears and elephants (Livius, xliv. 18); and Pompey on one occasion is said to have exhibited 500 lions (a number beyond all belief), which were all despatched in five days. (Dion. Cass., xxxix. 38.)

CISSAMPELINE. [PELOSINE.]

CISS'AMPELOS PAREIRA, the Pareira-brava, a native of several of the West Indian islands, of New Spain, and of Brazil. The root of this plant arrives in Europe in pieces from two to three feet long, varying in thickness from that of a finger to an arm, curved, furrowed, and warty, with a thin closely adhering bark of a grayish-brown colour. The woody part is tough, but so porous that air can be blown from one end to the other of a long piece; the concentric circles are very conspicuous; the axis is not in the centre. The odour is very faint, but the taste is at first sweetish or liquorice-like, afterwards nauseous and bitter. Analysed by Feneuille it was found to consist of—

Soft resin; a yellow bitter principle (tonic); a brown principle; animalised matter, starch, malate of lime, nitrate of potash, and other salts. Wiggers states that it contains a peculiar alkaloid, which he terms Cissampeline.

The juice of the fresh plant in its native country is said to be a very efficacious application to the bites of serpents; but in Europe the root is employed only as a tonic diuretic. It is particularly valuable in cases where there is a copious discharge of urine with a ropy alkaline mucus. (Brodie's 'Lectures on Diseases of the Urinary Organs.') It is also serviceable in catarrhus vesicæ, and other affections of the urino-genital organs.

There is great reason to believe that the roots of several different species of this or closely allied genera are confounded under the name of Pareira-brava, especially the root of Cissampelos Caapeba, also of C. Mauritanica (Aubl.), C. parroides (Decand.), which is much esteemed in the East Indies, given along with aromatics in diseases of the intestines. Two species of Aleuta, A. rufescens (Aub.) and A. candicans (Decand.), are used in Guiana.

The Pareira-brava contains so much mucilage that it coagulates water in which it is put to infuse. A syrup of this plant is a valuable demulcent in phthisis pulmonalis, or consumption.

CISSOID (*κισσο-ειδὴς*, resembling ivy), a name given to a curve first considered by Diocles (an Alexandrine, and posterior to Pappus, as is supposed from the latter not mentioning the name of Diocles among those who invented methods for inserting two mean proportionals 'Math. Coll.,' book iii. prop. 5), which rises towards an asymptote, and then obtained its fanciful name. It was one of the curves employed by the Greeks in the celebrated problem of finding two mean proportionals, and is described as follows: Let two points (A) and (B) move with equal velocities round a circle, setting out from the ends of a diameter in opposite directions of rotation. Let a straight line (P) always pass through the starting point of (A), and through (B) as it moves; and let an ordinate (Q) perpendicular to the line joining the two starting points always pass through (A) as it moves. Then the intersection of (P) and (Q) traces out the cissoid, which has the line joining the starting points for its tangent at the commencement, and the tangent to the circle passing through the starting point of (B) for its asymptote.

But the term cissoid has been applied in later times to all curves described in a similar manner, and where the generating curve is not a circle. The cissoid of the Greeks should then be called either the cissoid of Diocles or the circular cissoid. The starting point of (A) being the origin, the line joining the starting points the axis of x, and a the radius of the circle, the equation of the cissoid of Diocles is—

$$y^2 = x^3 \div (2a - x)$$

CISTERCIANS. [BERNARDINES; CÎTEAUX.]

CITADEL (remotely from the Latin *civitas*, and immediately from the Italian *cittadillo*), a fortified post within or adjoining a town. It serves either to keep the inhabitants in subjection, or as a place of retreat for the garrison when compelled to abandon the town to an enemy. A citadel should be constructed in a situation where it may be easily succoured; its fortifications should be stronger than those of the town, in order that the enemy may be induced to attack the latter first; and it should be separated from the buildings of the town by an esplanade.

CITATION, a process in the commencement of a suit by which a party is commanded to appear before the Ecclesiastical courts. The jurisdiction of these tribunals in testamentary and matrimonial causes has been transferred to the Courts of Probate and of Divorce; and the first process in a suit in either of these courts is a *citation*. This is not, however, in the form of the abolished process, from which its name is derived, but rather resembles the writs in use in the Courts of Common Law.

CÎTEAUX, or, as it was formerly written, CISTEAUX (in Latin, CISTERCIUM), the site of a celebrated abbey in the department of Côte d'Or, in France: it is about four miles east from the town of Nuys, which lies on the road from Dijon to Châlons sur Saône. This abbey owed its origin to Robert, prior of Moutier-le-Celle, who, after endeavouring in vain to reform the irregularities of his convent, was solicited to take the charge of a company of anchorets, with whom he founded the abbey of Molême, and instituted a stern ascetic discipline. But becoming unable to maintain a strict conformity to his rules, he obtained permission of the papal legate to withdraw with a few chosen associates in order to following the Benedictine rule in its severest form. Accompanied by twenty followers, he retired to the forest of Cîteaux in 1098. After a time, Robert was directed by the pope to return to his charge at Molême, where the disorders which had probably caused his retirement had proceeded to a great length, in which office he continued till his death in 1108. The third abbot of Cîteaux was Etienne or Stephen Harding, an Englishman (canonised as St. Etienne), who may be regarded as the real founder of the Cistercian order (les Cîteaux), as until his time no establishment had sprung from this monastery: in 1113-15 were founded the first four establishments of which this can be regarded as the parent.

The monks of this order have been sometimes called Bernardines, from St. Bernard, who joined Etienne in 1113; and sometimes White Monks, from their habit, a white cassock with a white gown for attending the church, but a black one when they went abroad. The abbey of Cîteaux was a very rich establishment previous to the Revolution. The community consisted usually of about 80 monks, beside 40 domestics. The church and a chapel under the portico contained the tombs of about 60 princes of the ducal house of Burgogne, who made this their chief burial-place. Among those who have been inmates of this house, are St. Bernard and the four popes, Eugenius III., Gregory VIII., Celestine IV., and Benedict XII. The church and monastery have been destroyed, and there are now but few remains. Stephen, also, instituted the first female convent of the Benedictine order, which was succeeded by many others, but that of Port Royal has been by far the most distinguished.

CI'THARA, an ancient stringed instrument of the lyre kind. That the names of the comparatively modern instruments, the gittern, or cittern, and guitar, are derived from the name of the Greek instrument (*κιθάρα*), we can have no doubt; and it is reasonable to infer, not only from similarity of appellation, but from the remains of antique art, that the modern instruments in many respects resemble that of the ancients. [LYRE.]

CITIZEN, from the French word *citoyen*, which remotely comes from the Latin *civis*. Aristotle commences the third book of his 'Politik' with an investigation of the question, What is a citizen (*πολίτης*)? He defines him to be one who participates in the judicial and legislative power in a state; but he observes that his definition strictly applies only to a democratical form of government. The Roman word Civis, in its original and proper sense, also meant one who had some share in the sovereign power in the state. The word citizen then, if we take it in its historical sense, cannot apply to those who are the subjects of an absolute monarch, or, in other words, of one who has the complete sovereign power. It is consistent with ancient usage and modern usage, and it is also convenient to apply the word citizen only to the members of republican governments, which term, as here understood, comprehends [REPUBLIC] constitutional monarchies. The term constitutional monarchy is not exact, but its meaning is understood: it is a form of republican government at the head of which is a king, or person with some equivalent title, whose power and dignity are hereditary. Constitutional monarchies approach near to absolute monarchies when the constitution gives very little power to the people, and this little power is rendered ineffectual by the contrivance of the prince and his advisers. Constitutional monarchies are of an aristocratical character when much political power is vested in the hands of a minority which is small when compared with the majority; or they may approach to a democracy, and differ from it mainly in having an hereditary instead of an elective head. Citizenship therefore is here understood as only applying to those states in which the constitution, whether written or unwritten, gives to those who are members of such states, or to some considerable number of them, some share of the sovereign power.

The usual form in which citizenship is acquired is by birth; by being born of citizens. In the old Greek states, and generally in those states of antiquity where citizenship existed, this was the only mode in which as a general rule it could be acquired. A person, not the son of a citizen, obtained no rights of citizenship by the mere circumstance of being born in a country or living there. Citizenship could only be conferred by a public act either on an individual or on all the members of other communities. Difference of religion was one of the causes of these communities excluding strangers from their political body. The Roman system was at first a close community, but the practice of admitting aliens (peregrini) to the citizenship was early introduced. They were even admitted by the old burgers (the patricians) in considerable numbers, but only by a vote of the collective body of patricians. The admission of aliens to the citizenship, either partial or complete, became a regular part of the Roman polity to which Rome owed the extension of her name, her language, and her power. It is true that the process of admission went on slowly, and for a long time the Romans unwisely, and with danger to their state, resisted the claims of their Italian allies, or subject people, who demanded the Roman citizenship; but this claim was finally settled in favour of the Italians by the Social or Marsic War (B.C. 90), and by the concessions that followed that war. The consequences of this war were, that all the inhabitants of Italy south of the Po became Roman citizens, and forty years afterwards the privilege was extended to the inhabitants north of the Po. We find some instances, before the Marsic war, of the states of Italy declining admission into the Roman political body; they preferred their own constitution to the rights and duties of Roman citizens. Under Justinian all free persons within the empire were Cives; but citizens had then become subjects, for the emperor was monarch.

The Roman system did not allow a man to claim the citizenship by birth, unless he was born of such a marriage as the state recognised to be a legal marriage. If a Roman married a woman who belonged to a people with whom the Roman state recognised no intermarriage (connubium), the child was not a Roman citizen; for he was not the legal child of his father, and it was only as the child of a Roman father that he could claim Roman citizenship. This was the strict principle; but it appears that if a Roman woman had a child by a man with whom there was no connubium, the child was legally a Roman citizen.

The English law gives the citizenship to all persons who are born anywhere of a British citizen or of one whose father or father's father was a citizen of Great Britain. The English law also gives the citizenship to every person born in the British dominions; which rule originated in the king claiming such persons as his subjects who were born within his dominions. In the earliest periods of English history, those were properly called subjects who may now properly be designated citizens, though citizenship in England must be divided into two kinds, as it was in Rome. Some native citizens do not enjoy the suffrage, nor are they eligible to certain offices, such for instance as a membership of the House of Commons. But these are not permanent and personal disabilities: they are temporary incapacities arising from not having a certain amount of property, and therefore the complete

citizenship may be acquired by every citizen who can acquire the requisite property qualification, with one or two trifling exceptions, such as a Jew or a Roman Catholic being disqualified from becoming Lord Chancellor. It follows from what has been said that those who happen to be under this disability are not full citizens, but have a capacity to become such. Those who have not the suffrage are in the situation of subjects to that sovereign body, of which those who possess the suffrage form a part. Thus the word subject may apply to some persons who live in a republic, as it does apply to all who live under a monarchy. The terms on which foreigners are admitted to the citizenship, are different in different countries. By the Act of Parliament 7 & 8 Vict. c. 76, the acquisition of partial citizenship in England is rendered much easier and less expensive than it was under the former process of a special Act of Parliament. [ALIEN.]

In ancient Rome, aliens were not always admitted to the full rights of Roman citizens; and indeed in the early history of the state, even the plebeians formed a body who were without many of the privileges which the patricians enjoyed. A person might receive the Roman citizenship so far as to enjoy every advantage except a vote at the public elections and access to the honours of the state. This however was not citizenship as understood by Aristotle, nor is it citizenship as understood by the free states of modern times. The acquisition of complete citizenship implies the acquisition of a share of the sovereign power: the acquisition of all the rights of a citizen, except the suffrage and access to the honours of the state, is a limited citizenship; and it is no more than may be acquired in those states where there is no representative body, and in which a man by such acquisition gets not citizenship, but the state gets a subject.

The great facilities for a man changing his residence which now exist, and the increased motives to such change in a desire to better his condition by permanently settling in another country, lead to emigration from one country to another, and more particularly from Europe to America. The advantage which any country receives from the emigration of those who possess capital or peculiar arts is so great that, under the present circumstances of the world, it is not easy to discover any good reason for republican governments refusing to give the citizenship to any person who comes to another country with the view of settling there. A difficulty will arise in case of war when a man owes a divided allegiance, for it is a principle of English law that a man cannot divest himself of his allegiance to the king of England; and probably an American citizen cannot divest himself of his allegiance to the United States. And yet the two countries which maintain this principle, allow the citizens of any other country to become citizens of their several communities. The Roman principle under the Republic was, that as soon as a Roman was admitted a citizen of another state, he ceased to be a Roman citizen, because a man could not belong to two states at once; wherein we have one among many examples of the precision of Roman political principles. The same principle must certainly be adopted some time into the international law of modern states.

The nations of Europe and the states of the two Americas have all a common religion, which however contains a great number of sects. A person of any religion in the United States of North America may become a citizen, and his opinions are no obstacle to his enjoying any of the honours of the country. But this was not so in England till 1858. No man for instance, though an English citizen, could be a member of the House of Commons unless he was, or was willing to profess that he was, a Christian. The declaration made by members of the House of Commons, which contained the words "upon the true faith of a Christian," excluded all who did not profess Christianity. In 1858, after several Jews had been elected members and had been prevented from sitting, an Act was passed, by which the House of Commons is enabled, by resolution, to exempt any member from repeating that part of the declaration.

A great number of foreigners, particularly from Great Britain and Ireland, and from some of the German states, annually settle in the United States of North America; and it is now alleged that by their numbers they materially affect the elections. It is also alleged that many of them are very ignorant, and for want of previous education and proper habits are incompetent to exercise the functions of an American citizen. It is further alleged that a great many of them are Roman Catholics, who are under a sort of obedience to a foreign prince, the Pope of Rome, and hostile to the principles of the American constitution. For these and other like reasons it has been proposed that a longer term of probation than five years should be required of aliens before they are admitted to the franchise; and a party which calls itself the American Republican party would make the period of probation twenty-one years. It is admitted in the argument of their party that if foreigners on settling in the United States are not allowed to have the franchise during the period of probation, they are during that period subjects to the citizens of the United States and not American citizens; which is consistent with what Aristotle says ('Pol.' iii. 1). If the period of probation is extended to twenty-one years, the citizens of the United States will have among them a great number of subjects—a great number of persons who will be as much their subjects as the people of Prussia are the subjects of the king of Prussia. The period of twenty-one years will comprehend the whole life of the great body of immigrants, and this body will be very numerous. The immigrants will enjoy no more privileges than aliens can enjoy in most countries of Europe, but they will have before their eyes the daily spectacle of a large number of citizens who do enjoy rights which they do not. Whether all these circumstances will render the government of so large a body of subjects an easier thing to deal with than the difficulties that are alleged to grow out of the present terms on which the citizenship is given, remains to be seen. The declared hostility of the American Republican party to the Roman Catholic religion, the religion of a great number of the immigrants, is calculated to embitter these immigrants still more if they are deprived of the power of attaining the citizenship. The United States already possess a great number of slaves who are subjects, and a large body of free coloured people who are looked upon as a different caste. To these a party now proposes to add a large body of alien subjects, to add to the elements of discord one element more; and that a more powerful element than all the rest. Undoubtedly, the great amount of immigration into the United States is not a pure advantage to that country, but the call for different terms of naturalisation seems to proceed more from party and religious feeling than to be founded on sober reflection. If we consider the measures proposed, the reasons given for them, and the temper with which they are urged, we must agree with the party which urges them, that the American nation has rapidly grown up "without political experience adequate to govern their own mighty physical power."

In a narrower sense the term citizen is used to denote the freeman or elector of the corporation of a city, as distinguished from a burgher, the elector of a borough.

CITOLE, a musical instrument mentioned in the 'Confessio Amantis' of Gower, which was, Sir John Hawkins conjectures, a dulcimer.

CITRACARTIC ACID. [CITRIC ACID, *Mesaconic Acid.*]

CITRACONAMIC ACID ($C_{10}H_7NO_6$). An acid obtained as an ammoniacal salt, by boiling *citraconimide* with ammonia. Its salts are uncrystallisable.

CITRACONANILE. [CITRIC GROUP.]

CITRACONANILIC ACID. [CITRIC GROUP.]

CITRACONATES. [CITRIC ACID, *Citraconic Acid.*]

CITRACON-DINITRANILE. [CITRIC GROUP.]

CITRACONIC ACID. [CITRIC ACID.]

CITRACONIMIDE. [CITRIC GROUP.]

CITRACONIODANILE. [CITRIC GROUP.]

CITRAMIDE. [CITRIC ACID.]

CITRANILIC ACID. [CITRIC ACID.]

CITRANILIDE. [CITRIC ACID.]

CITRATES. [CITRIC ACID.]

CITREN ($C_{10}H_8$). The volatile oil of lemons consists almost entirely of a peculiar carburetted hydrogen, to which the name of citren has been given. It is sometimes called citronyl.

CITRIBIC ACID. [CITRIC ACID.]

CITRIC ACID ($C_{12}H_8O_{14}$). This acid, discovered in 1784 by Scheele, in orange juice, exists in the free state, or as acid salt, in the juice of several fruits, as lemons, oranges, cherries, strawberries, red currants, &c., and in the berries of several vegetables; and to its presence the agreeable acidity of these fruits is due. It is usually prepared from lime-juice, which for this purpose is largely imported from Sicily. In order to obtain the acid, the lime-juice is allowed to stand until it undergoes incipient fermentation, by which certain mucilaginous matters are got rid of, and a clear liquor is obtained. This is neutralised, at first with chalk, and afterwards with caustic lime. An insoluble citrate of lime is hereby formed, which is washed with water, and then decomposed by the addition of a slight excess of dilute sulphuric acid. The liquid filtered from the sulphate of lime, and evaporated, yields crystals on cooling. The slight excess of acid promotes the crystallisation.

The acid is present in large quantities in gooseberries, from the expressed juice of which it may be obtained by the above process. The berries should be collected before they are ripe.

Citric acid crystallises in rhomboidal prisms, which have a strong and agreeable acid taste. It is soluble in alcohol, and more so in water. It is almost insoluble in ether. The crystals obtained by the spontaneous evaporation of a cold saturated solution, have the formula $C_{12}H_5O_{11}, 3HO + 2HO$; those deposited by the cooling of a hot solution have the composition $C_{12}H_5O_{11}, 3HO + HO$. A dilute aqueous solution becomes mouldy on standing.

It does not precipitate potash salts, and the presence of tartaric acid, with which it is frequently adulterated, may be detected by adding to a solution of the acid a little acetate of potash; the formation of a precipitate indicates the presence of tartaric acid. When solution of citric acid is added to lime-water, the liquid remains transparent, but on being heated deposits citrate of lime. This deportment serves to distinguish it from tartaric acid.

Heated with hydrate of potash, at a temperature of 392° Fahr., it is decomposed, with formation of acetate and oxalate of potash:—

$$\underbrace{C_{12}H_8O_{14}}_{\text{Citric acid.}} + 4KO = \underbrace{2KO, C_4O_6}_{\text{Neutral oxalate of potash.}} + \underbrace{2(KOC_4H_3O_3)}_{\text{Acetate of potash.}} + 2HO$$

Dry citric acid is decomposed, by treating with strong sulphuric acid,

into carbonic oxide, carbonic acid, and other products. By sulphuric acid and bichromate of potash it is oxidised into formic acid and carbonic acid. Dilute nitric acid does not attack citric acid in the cold; at a high temperature it oxidises it, with the formation of oxalic, acetic, and carbonic acids. A concentrated aqueous solution absorbs chlorine very rapidly when exposed to the sunlight: a yellowish oil is obtained, of a sweet but burning taste, and an irritating odour. Agitated with water, and cooled, the oil solidifies to a mass of crystals. The action of chlorine on citrate of soda produces different results,—an oil of complex composition is obtained, containing chloroform. Bromine gives similar results.

When crystallised citric acid is subjected to destructive distillation, it first melts, gives off its water of crystallisation, and at about 350° Fahr. it undergoes decomposition; gases and inflammable vapours are formed, and the residue no longer consists of citric acid, but is *aconitic acid*, called also *equisetic* or *atridic acid* ($C_{12}H_3O_9$, 3HO). If the heat be still increased, dense vapours appear, which condense to oily drops, and afterwards solidify to a crystalline mass of *itaconic acid* ($C_{10}H_4O_8$,2HO); and if these crystals be repeatedly distilled, an oily mass of *anhydrous citraconic acid* ($C_{10}H_4O_6$), called also *pyrocitric* and *citribic acid*, is obtained, which does not solidify.

Citric acid is extensively used as a mordant in calico-printing. It is used in pharmacy for the preparation of syrups and lemonade. Mixed in small proportion with sugar and aromatic substances, it serves to form dry lemonade.

The crystallised acid loses two equivalents of water when heated below 212°. Its composition then is $C_{12}H_8O_{14} = C_{12}H_5O_{11}$, 3HO.

Citric acid is a tribasic acid, and is capable of forming three series of salts. It contains the tribasic radical *cetryl*, $C_{12}H_5O_8$, which, when united with three equivalents of oxygen, forms the anhydrous acid, $C_{12}H_5O_{11}$; and united with three equivalents of chlorine, forms the chloride of *citryl*, $C_{12}H_5O_8$, Cl_3.

The composition of the citrates may be thus written :—

Neutral .	trimetallic citrates . .	$C_{12}H_5O_{11}$, 3MO
Acid . .	bimetallic citrates .	$C_{12}H_5O_{11}$, (2MO + HO)
Acid .	monometallic citrates .	$C_{12}H_5O_{11}$, (MO + 2HO)

Citric acid also forms polybasic salts; with lead this is more especially the case. Their general formula may be written—

$$C_{12}H_5O_{11}, 3MO + xMO.$$

The alkaline citrates are very soluble in water, and crystallisable with more or less facility. Like the tartrates, they prevent the precipitation of the salts of iron, manganese, &c., by alkalies. The citrates of magnesia, zinc, iron, cobalt, nickel are soluble. The neutral citrates of baryta, strontia, lime, on the other hand, are very little soluble; the acid salts more so. The citrate, and ammonio-citrate of iron, are frequently used in medicine. Their exact composition is not known.

Citric ethers.—The ethers of citric acid correspond to citrates in which the metal is replaced by its equivalent of methyl, ethyl, or amyl. The acid ethers form salts with bases :—

Methylocitric ether .	$C_{14}H_{10}O_{14} = C_{12}H_5O_{11}, \left.\begin{matrix} C_2H_3O \\ 2H\ O \end{matrix}\right\}$
Bimethylocitric ether .	$C_{16}H_{12}O_{14} = C_{12}H_5O_{11}, \left.\begin{matrix} 2C_2H_3O \\ H\ O \end{matrix}\right\}$
Neutral citrate of methyl	$C_{18}H_{14}O_{14} = C_{12}H_5O_{11}, 3C_2H_3O$
Neutral citrate of ethyl	$C_{24}H_{20}O_{14} = C_{12}H_5O_{11}, 3C_4H_5O$

Citric ether, or neutral citrate of ethyl, is best prepared by saturating an alcoholic solution of citric acid with hydrochloric acid. The free acid is neutralised with carbonate of soda, and the residue treated with ether. On the evaporation of the ether, the citrate of ethyl is left as a yellowish, transparent, heavy oil, which cannot be distilled without decomposition.

Amylocitric acid $\left.\begin{matrix} C_{22}H_{18}O_{14} = C_{12}H_5O_{11}, C_{10}H_{11}O \\ 2HO \end{matrix}\right\}$ obtained by digesting citric acid with amylic alcohol, is a viscous liquid presenting traces of crystallisation. It forms crystallisable salts with alkalies. *Acid citrate of ethyl and amyl* $C_{26}H_{22}O_{14} = \left.\begin{matrix} C_{12}H_5O_{11}, C_{10}H_{11}O \\ C_4H_5O \\ HO \end{matrix}\right\}$ is obtained by saturating an alcoholic solution of the preceding compound with hydrochloric acid.

Amides and anilides of citric acid. The only amide of citric acid known is *citramide* ($C_{12}H_{11}N_3O_8$), prepared by the action of ammonia on citric ether. It represents neutral citrate of ammonia, minus six equivalents of water.

$$3\,NH_4O, C_{12}H_5O_{11} - 6HO = C_{12}N_3H_{11}O_8.$$

Citramide may be regarded as being 3 eq. of ammonia, in which the tribasic radical *citryl* ($C_{12}H_5O_8$) replaces 3 eq. of hydrogen $\left.\begin{matrix} C_{12}H_5O_8''' \\ H_3 \\ H_3 \end{matrix}\right\} N_3$.

Being a tribasic acid, citric acid ought to form amide compounds, corresponding to each of its ammonia salts. These have not been obtained, but Pebal has investigated the corresponding anilide compounds. They are formed by the action of aniline on citric acid, under varying conditions. They are of complex constitution and great

theoretical interest. For a full account the reader is referred to the original papers in Liebig's 'Annalen,' or Watts' English edition of Gmelin's 'Handbook of Chemistry.' A few only are enumerated here.

Citranilide, or *phenylcitramide* ($C_{48}N_3H_{23}O_8$), is tribasic citrate of aniline, minus 6 atoms water.

$$\underbrace{C_{12}H_8(C_{12}H_7N)_3O_{14}}_{\text{Tribasic citrate of aniline.}} - 6HO = \underbrace{C_{48}N_3H_{23}O_8}_{\text{Citranilide.}}$$

It may be considered to be derived from 3 atoms NH_3, in which 3 atoms H are replaced by the radical citryl, and by 3 atoms of phenyl $\left.\begin{matrix} C_{12}H_5O_8''' \\ (C_{12}H_5)_3 \\ H_3 \end{matrix}\right\} N_3$.

Citrobianile, or *phenylcitramide* ($C_{36}H_{16}N_2O_8$), a neutral body, formed from bibasic citrate of aniline by the loss of 6 atoms water.

$$\underbrace{C_{12}H_8O_{14}, 2C_{12}H_7N}_{\text{Bibasic citrate of aniline.}} - 6HO = \underbrace{C_{36}H_{16}N_2O_8}_{\text{Citrobianile.}}$$

It may be viewed as a diamide, that is, 2 eq. of ammonia, in which 3 atoms hydrogen are replaced by citryl, and 2 atoms by 2 of phenyl = $\left.\begin{matrix} C_{12}H_5O_8''' \\ (C_{12}H_5)_2 \\ H \end{matrix}\right\} N_2$.

Citrobianilic acid ($C_{36}N_2H_{18}O_{10}$) is bibasic citrate of aniline — 4 atoms water. It forms crystalline salts.

$$\underbrace{C_{12}H_8O_{14}, 2C_{12}H_7N}_{\text{Bibasic citrate of aniline.}} - 4HO = \underbrace{C_{36}N_2H_{18}O_{10}}_{\text{Citrobianilic acid.}}$$

Citranilic acid $C_{24}NH_{11}O_{10}$, obtained by the action of heat on monobasic citrate of aniline.

$$C_{12}NH_7, C_{12}H_8O_{14} - 4HO = C_{24}NH_{11}O_{10}.$$

It may be derived from the type, hydrated oxide of ammonium $\left.\begin{matrix} NH_4 \\ H \end{matrix}\right\} O_2$ in which 3 at. are replaced by citryl, and 1 at. H by phenyl, $N, C_{12}H_5.\ \left.\begin{matrix} C_{12}H_5O^{8'''} \\ H \end{matrix}\right\} O_2$. It forms crystalline salts.

Chloride of citryl ($C_{12}H_5O_8Cl_3$). When citric acid is treated with pentachloride of phosphorus it becomes heated, and yields a mixture of oxychloride of phosphorus and *oxychlorocitric acid*, $C_{12}H_8O_{12}Cl_2$, a body crystallising in long silky needles, and which, with water, regenerates citric acid and hydrochloric acid. The mixture further heated, gives off hydrochloric acid and *chloride of citryl*, $C_{12}H_5O_8Cl_3$, appears to be formed.

Acids derived from citric acid by the action of heat.

Aconitic acid, $C_{12}H_6O_{12} = C_{12}H_3O_9$, 3HO. This acid is found as lime salt in many species of *aconite*. It is also found in *equisetum*, and was termed *equisetic acid*. It is formed from citric acid by heat, and this is its best source. Citric acid is distilled until crystalline striæ appear in the receiver. The residue dissolved in alcohol, and saturated with hydrochloric acid, forms aconitic ether, which treated by potash yields aconitate of potash. This is precipitated by a soluble lead salt, and the aconitate of lead formed decomposed by sulphuretted hydrogen, and the filtrate from the sulphide of lead evaporated.

It forms indistinct crystals, very soluble in alcohol and ether. It is formed from citric acid by simple loss of water.

$$\underbrace{C_{13}H_8O_{14}}_{\text{Citric acid.}} - 2HO = \underbrace{C_{12}H_6O_{12}}_{\text{Aconitic acid.}}$$

Aconitic acid when heated assumes an amber colour, melts and boils at 320° Fahr. It then decomposes into carbonic acid, and a new acid, *itaconic acid*, which may be condensed in the receiver.

$$\underbrace{C_{12}H_6O_{12}}_{\text{Aconitic acid.}} = 2CO_2 + \underbrace{C_{10}H_6O_8}_{\text{Itaconic acid.}}$$

By this decomposition aconitic acid is distinguished from its isomers, fumaric and maleic acids.

Aconitate of lime, placed in water in contact with decaying cheese, is changed into succinic acid. Like citric acid, it forms three series of salts—monometallic, $C_{12}H_3O_9$,(MO+2HO); bimetallic, $C_{12}H_3O_9$, (2MO + HO); and trimetallic, $C_{12}H_3O_9$, 3MO. They are little known, and are of no great interest.

Aconitic ether ($C_{12}H_3O_9$, $3C_4H_5O$), obtained as above in the preparation of aconitic acid, is a colourless aromatic liquid, with a very bitter taste. It is rather heavier than water and boils at 425° Fahr.

By the action of aniline on aconitic acid compounds are obtained analogous to those derived from citric acid.

Pyrocitric acids. Under this name Gerhardt classes three isomeric acids derived from citric acid. They are itaconic, citraconic, and mesaconic acids.

Itaconic acid ($C_{10}H_6O_8$) occurs among the distillation products of citric acid, and is derived from the decomposition of aconitic acid. Citric acid is heated in a retort by means of a spirit lamp, until yellowish vapours, and an oily liquid passes over, which solidifies to crystals—these are pressed and recrystallised from water. Its crystalline form is a rhombo-hedral octohedron. It is inodorous, and has a strongly acid taste. Tolerably soluble in cold, and much more so in hot water. By heat it decomposes into anhydrous citraconic acid, and water.

$$\underbrace{C_{10}H_6O_8}_{\text{Itaconic acid.}} = 2HO + \underbrace{C_{10}H_4O_6}_{\text{Anhydrous citraconic acid.}}$$

It is bibasic, and forms two series of salts: $C_{10}H_4O_6,(MO+HO)$ and $C_{10}H_4O_6,2MO$.

Citraconic Acid ($C_{10}H_6O_8 = C_{10}H_4O_6,2HO$). In the later stage of the distillation of citric acid an oily liquid passes over, which is *anhydrous citraconic acid* ($C_{10}H_4O_6$). When exposed to the air it attracts moisture, and becomes slowly converted into a crystalline mass of citraconic acid ($C_{10}H_6O_8$). Citraconic acid is isomeric with itaconic acid, but differs from that substance in its crystalline form, which is a four-sided prism, and also in being more soluble in water. Small quantities heated for some time to 212° are converted into itaconic acid. Citraconic acid is bibasic, like itaconic acid, and forms two series of salts.

Mesaconic acid, Citracartic acid ($C_{10}H_6O_8$). When a weak solution of citraconic acid is digested for some with about $\frac{1}{16}$th its volume of nitric acid, the liquid deposits after some time crystalline masses, of an aspect like porcelain, which when purified have the form of somewhat brilliant needles, which sublime without alteration, and are very slightly soluble in water, consist of mesaconic acid, and are produced by a simple isomeric transformation of citraconic acid. Itaconic acid, when acted upon by nitric acid, does not yield mesaconic acid. Mesaconic acid is bibasic, and forms two series of well defined salts.

The neutral ethers of these three isomeric acids, *itaconate, citraconate,* and *mesaconate of ethyl,* are also isomeric, and their formula is $C_{10}H_4O_6,2C_4H_5O$. They are all produced by dissolving the acid in alcohol, and etherifying by means of hydrochloric acid. The two former are oily aromatic liquids with a bitter taste, slightly heavier than water. They boil at 437° Fahr. under partial decomposition. Mesaconic ether has a pleasant fruity odour, it boils at 428° Fahr., and distils without alteration.

Brominated derivatives of the pyrocitric acids. By the action of bromine on either neutral citraconate or itaconate of potash in the presence of water, carbonic acid is evolved, and a yellow oil deposited which is a mixture of two substances. The one is a heavy, neutral, amber-coloured fluid; its formula is $C_6H_3Br_3O_2$ which is that of a terbrominated acetone or terbrominated propionic aldehyde. The other substance is *bromotriconic acid,* and can be separated from the mixture by potash. Frequently, after standing, the oil solidifies to a mass of crystals. It forms salts. Its formula is $C_8H_6Br_2O_4$ which is that of a bibrominated butyric acid; but its discoverer, M. Cahours, was not able to prepare it from butyric acid.

If bromine act on citraconate or itaconate of potash in the presence of excess of potash, the reaction appears to take place in an analogous manner, but the resultant product is an acid, *bromitonic acid* ($C_6H_4Br_2O_4$), or a bibrominated propionic acid.

Chloride of pyrocitryl ($C_{10}H_4O_4,Cl_2$). This substance is produced by the action of pentachloride of phosphorus on anhydrous citraconic acid. It is a fuming, heavy, refringent liquid, which boils at 347° Fahr. It is decomposed by water into hydrochloric and citraconic acids.

The amides and anilides of the pyrocitric acids have been carefully investigated by Gottlieb, to whose papers in Liebig's 'Annalen,' vols. 77 and 85, the reader is referred for details.

CITRIC GROUP. A family of organic compounds belonging to the *acetic* series. It comprehends citric acid and its derivatives. The citric group is attached to the acetic series by several reactions: for instance, citric acid gives by destructive distillation *acetone,* and when heated with hydrate of potash it is converted into acetate and oxalate of potash. The following are amongst the principal members of this group:—

Citric acid	$C_{12}H_8O_{14}$
Citramide	$C_{12}H_{11}N_3O_8$
Aconitic acid	$C_{12}H_6O_{12}$
Pyrocitric acid	$C_{10}H_6O_8$
Pyrocitramide	$C_{10}H_8N_2O_4$
Pyrocitramic acid	$C_{10}H_7NO_6$
Pyrocitrimide	$C_{10}H_5NO_4$
Citric ether	$C_{12}H_5O_{11}, 3C_4H_5O$
Citraconanile	$C_{10}H_4(C_{12}H_5)NO_4$
Citracondinitranile	$C_{10}H_4(C_{12}H_3(NO_4)_2(NO_4$
Citraconimide	$C_{10}H_5NO_4$
Citraconiodanide	$C_{10}H_4(C_{12}H_4I)NO_4$

For a detailed description of such of these bodies as are not mentioned under their respective names, see Gerhardt's 'Traité de Chimie,' vol. ii. p. 85.

CITROBIANILE. [Citric Acid.]

CITROBIANILIC ACID. [Citric Acid.]

CITRONYL. [Citren.]

CITRUS AURANTIUM, ORANGE, of which there are two species, the sweet, or China orange, *Citrus Aurantium, Risso,* and *C. Bigaradia, Risso,* and the bitter, or Seville. The fruit of the latter, while small and unripe, is collected and dried: the smallest, which are of the size of a pea, are used for keeping issues open, and the larger for the preparation of the liqueur called Curaçoa. Of the ripe fruit every part is used either medicinally or dietetically. The rind, called flavedo, contains a bitter principle and much volatile oil; and either used at dessert, or reduced to powder and added to magnesia and rhubarb, furnishes a grateful tonic to the stomach in some forms of dyspepsia and gout. The pulp and juice are exceedingly agreeable to persons affected with inflammatory complaints, or a drink prepared from it (orangeade) is of great utility in bilious and gastric fevers, dysentery, &c. The roasted pulp forms an excellent application to fetid ulcers.

The peel of lemons is likewise employed, but it is not so warm and grateful as that of oranges, from containing less volatile oil. The powers of lemon juice are much increased by saturating it with chloride of sodium (common table-salt). It is then of great efficacy in the treatment of dysentery, remittent fever, the dry belly-ache, putrid sore throat, and other diseases occurring in the West Indies. Dr. Wright also recommends it in diabetes and lientery. Similarly mixed with table-salt, but without sugar, it is one of the best drinks against sea sickness.

Citric acid exists in numerous fruits, particularly those of the orange tribe, such as the lemon and lime, either alone, or with malic and other acids; sugar, mucilage, and extractive are also present. The citric acid is separated and purified on a large scale, in the way before mentioned. [Citric Acid.] It is frequently adulterated with other acids, such as tartaric, sulphuric, muriatic, and oxalic, which may be detected by appropriate tests. Citric acid, when crystallised, has scarcely any odour, but a very distinct acid taste. It is soluble in cold, but more abundantly in warm water. Citric acid has the power of curdling the milk of most animals, but not the human milk.

As it is impossible to treat of citric acid apart from lemon juice, we class them together. The impression of both on the organ of taste is the same in kind, but different in degree. Concentrated citric acid is somewhat caustic, but lemon juice is gratefully acid. To imitate the natural state, citric acid is only given largely diluted. In this state it proves a pleasant drink in fevers and diseases where the temperature of the body rises above the natural standard. According to Broussais, it agrees better than any other acid with the stomach when affected with acute inflammation. It is not so pleasant as lemonade prepared from new fresh lemons, and according to the statement of Sir G. Blane, the solution of citric acid is not so efficacious in the prevention and cure of sea-scurvy as the recent lemon juice. This is attributable to the absence of the volatile oil and the bitter principle of the rind, which are valuable adjuncts to the citric acid in its action on the stomach. The utility of lemon juice in promoting the digestion of gelatinous meats, such as veal and turtle, is well known. Fresh lemon juice may be preserved in bottles in the same way as ripe fruits, by boiling the bottles in which it is contained for half an hour, first placing them in cold water, and gradually heating it, and as soon as the contents of the bottles have fallen to the temperature of the air, closing them hermetically. Where lemon juice so preserved, or fresh lemons, cannot be obtained by ships on long voyages, the dissolved citric acid, to which a portion of an alcoholic extract of lemon peel may be added at the time of using, must serve as a substitute, should any apprehensions of scurvy be entertained. Its efficacy as a daily drink, without sugar, properly diluted, in improving the health of feeble children, is most striking.

Lemon juice is often a means of correcting acidity in the stomach, since, like most vegetable acids, it elevates the vitality of that organ, and prevents the formation of an excess of acid. On the same principle it is found to be a useful agent in elevating the powers of the stomach in the intermittent, remittent, and bilious fevers of America, many cases of which have yielded to a combination of lemon juice, cinchona bark, and port wine. Lemon-juice has been recommended on theoretical grounds, in acute rheumatism and gout, in large doses several times a day. Doubtless, its power in improving the condition of the digestive organs, may render it useful in some cases of these disorders. Lemon juice is often employed to rouse the stomach and nervous system after narcotic poisoning; but neither it nor vinegar should be used till all the poisonous substance is evacuated from the stomach, otherwise it increases the power of the poison.

Citric acid, as well as lemon juice, is much employed to decompose alkaline carbonates, forming therewith pleasant effervescing solutions. These taken in the act of effervescence are often of great utility in checking vomiting, and in reducing the temperature in inflammatory complaints. But in all cases of debility the employment of citric, or any other vegetable acid, for this purpose, is decidedly improper. The amount of injury done by the indiscriminate use of effervescing draughts made with a vegetable acid is incalculable. "Were I required," says Dr. Prout, "to name the medicine calculated to do the most mischief, I should name the common saline draught formed of potash or soda and some vegetable acid."

Citric acid alone is very useful in the phosphatic diathesis; it is the alkaline base in this combination which does harm. [Carbonic Acid.]

Externally citric acid largely diluted has been beneficially employed as a refrigerating wash, in the same way as vinegar. Slices of lemon form useful applications to scorbutic and other sores, and also at the commencement of hospital gangrene.

CITRYL. [CITRIC ACID.]

CITTERN (or *gittern*, or *guiltern*), a musical instrument of the lute kind, mentioned by our old dramatists. [CITHARA.]

CITY. Certain large and ancient towns both in England and in other countries are called cities, and they are supposed to rank before other towns. On what the distinction is founded is not well ascertained. The word seems to be one of common parlance, or at most to be used in the letters and charters of sovereigns as a complimentary or honorary compellation, rather than as betokening the possession of any social privileges which may not, and in fact do not belong to other ancient and incorporated places which are still known only by the name of towns or boroughs.

Sir William Blackstone is unfortunate in his attempt to define it. "A city," he says, "is a town incorporated, which is or hath been the see of a bishop." ('Comm.,' *Introd.*, section iv.) But Westminster is a city, though it is not incorporated. Thetford is but a town, though incorporated, and once the seat of a bishop. Whether Westminster owes its designation to the circumstance that it had a bishop for a few years of the reign of Henry VIII., and in the reign of Edward VI., may be doubted. But there are, besides Thetford, many places which were once the seats of bishops, as Sherburn, and Dorchester in Oxfordshire, which are never called cities. On the whole we can rather say that certain of our ancient towns are called cities, and their inhabitants citizens, than show why this distinction prevails and what are the criteria by which they are distinguished from other towns. These ancient towns are those in which the cathedral of a bishop is found; to which are to be added Bath and Coventry, which, jointly with Wells and Lichfield, occur in the designation of the bishop in whose diocese they are situated; and Westminster, which in this respect stands alone. Manchester, after having become the seat of a bishop, was incorporated as a city; but Ripon, also made the seat of a bishopric, remains a borough.

CIVET. This substance, which possesses an odour analogous to musk, is obtained from two species of animals, namely, the *Viverra zibetha* and the *Viverra civetta*. By distillation civet yields an essential oil to which its odour is due.

CIVIC CROWN. Among the Romans the civic was considered more honourable than any other crown. It was the recompense for the life of a citizen saved, either in battle or assault. A civic crown was conferred on Cicero for detecting Catiline's conspiracy; and afterwards upon Augustus, the reverse of many of whose coins bears the representation of it, with the inscription OB CIVES SERVATOS. This crown, which was in fact a wreath, was at first of elm, afterwards beech was used, and lastly, and most generally, oak. (Rasche's 'Lexicon Rei Numariæ.') Plutarch, in the life of Caius Marius Coriolanus, has given what he considers to be the reasons for the choice of the oak. Pliny informs us that the civic crown was the foundation of many privileges. He who had once obtained it had a right to wear it always. When he appeared at any of the public shows, the senators rose to do him honour; and he was placed near their bench. He was excused from all troublesome duties and services; and his crown procured the same immunity for his father and his grandfather on his own side. (The reader may consult for further information, Polyb. lib. vi. c. 37; Plin. 'Hist. Nat.' lib. xvi. c. 4; Tacitus, 'Ann.' lib. iii. § 21; xv. § 12.)

CIVIL LAW. This term is used in different senses. The Romans understood by the expression, "jus civile," the law, "quod quisque populus sibi constituit." In this sense, therefore, civil law might be defined to be the law of any particular nation or state. In place of this original and proper signification of the term, the expression "municipal law" has, however, very inappropriately been used by English writers; and civil law, in a more restrained sense, has now come to signify the law of the ancient Romans. [ROMAN LAW.] The term Civil law (the French *droit civil*, the German *Civil-Recht*) is still used, particularly in Germany and France, in another and limited sense, to denote the law given by the competent power of the state for regulating the mutual rights and obligations of the citizens or subjects as private persons; hence the expression "Civil Code" (*code civil*), and among the Germans, *civil*, or *bürgerliches Gesetzbuch*. [CODIFICATION.] German lawyers therefore say that civil law is a part of private law (*privat-recht*.) In this sense civil law is distinguished from other branches of law, as, for example, criminal law, ecclesiastical law, &c.

CIVIL LIST, as the words imply, was formerly the name given to the list of all the expenses of the civil government of the country, or of all the heads of public expenditure, excepting those of the army, the navy, and the other military departments. Originally in this country all the expenses of the government, the military expenses not excepted, were comprehended in one general list, and defrayed out of what was called the royal revenue. For a considerable period after the Conquest the royal revenue was derived from the rents of the crown lands, and from other sources which were at the command of the crown through the exercise of the prerogative. Both the collection and the expenditure of the whole were under the uncontrolled management of the king. Even when, at a later period, the greater portion of the expenses of the government came to be granted by parliament in the form of supplies, the entire expenditure was still left with the crown, the supplies being either voted for no specific purpose, or when it was otherwise, no responsibility as to the application of them being enforced.

This state of things continued to the Restoration. A distinction was then made between the military expenses of the government, or those occasioned by the wars in which the country might be involved, and which were considered of the nature of extraordinary expenses, and those incurred in the maintenance of the ordinary establishments of the country. The revenues appropriated to the latter were called the hereditary or civil-list revenues, and were provided for partly from the crown lands that remained unalienated, and partly from certain taxes imposed by parliament expressly for that purpose during the life of the reigning king. The civil list thus obtained amounted, during the reign of William III., on an average of years, to the annual sum of about 680,000*l*. Out of this sum were paid the expenses of the royal household, of the privy purse, of the maintenance and repairs of the royal palaces, the salaries of the lord chancellor, of the judges, of the great officers of state, and of the ambassadors at foreign courts; the incomes of the members of the royal family, and many other pensions, the secret service money, and a long list of other claims. The interest of the national debt, however, was never defrayed from the sum allotted for the civil list. In succeeding reigns, while the amount of the civil list was increased, the appropriation remained much the same. On the accession of George III., the amount of the civil list, 800,000*l*., was voted by parliament, but no particular taxes were set apart to provide for it, and this practice has ever since continued. In 1780 Mr. Burke brought in his bill for the better regulation of the civil list, which, although it was greatly mutilated before it passed into a law (in 1782), abolished several useless offices, and effected some reduction of expenditure. Expenses, however, still continued to grow, and at length, in 1812, the annuities to various branches of the royal family, to the amount of 260,000*l*., were tranferred to the consolidated fund. It was again raised, on the accession of George IV., by transferring charges to the same fund, to the amount of 255,000*l*. per annum. By the Act 1 Will. IV., c. 25, the civil list is confined to expenses proper for the maintenance of the royal household; and in the year ended June 30, 1859, the amount of the civil list, which is voted annually, was 402,835*l*. Her Majesty also retains the revenues of the duchy of Lancaster, which are considered to be the hereditary revenues, not of the crown, but of the dukedom of Lancaster, which is permanently annexed to the crown. The duchy of Cornwall belongs to the Prince of Wales. The charges which used to be defrayed from the civil list are now provided for separately, and in the same year mentioned above were as follow: annuities and pensions, 346,678*l*.; salaries and allowances, 158,624*l*.; diplomatic salaries and pensions, 163,066*l*.; courts of justice, 722,889*l*.; and miscellaneous charges, 175,738*l*.; making a total of 1,969,830*l*.

CLAIM IN CHANCERY. [EQUITY.]

CLAN, in Gaelic *Clann*, which is said to signify children or descendants. The word has been long adopted as English. Milton says,

> "They around the flag
> Of each his faction, in their several clans," &c.
> *Par. Lost*, ii. 901.

The clans of the Highlands of Scotland are families, or rather tribes, all the members of which bear the same surname, and are supposed to be descended from a common ancestor, of whom the chief of the clan is the lineal representative. Camden, and indeed all other authorities, speak of the Lowlanders and Highlanders as two distinct peoples; and they were generally hostile to each other, though under the same sovereign. Fletcher of Saltoun, in 1698, says of them: "It were to be wished that the government would think fit to transplant that handful of people and their masters (who have always disturbed our peace) into the Low country, and people the Highlands from hence, rather than they should continue to be a perpetual occasion of mischief to us." "Being divided," says Camden, speaking of the Scotch Highlanders, "into families, which they call clans, what with plundering and murdering, they commit such barbarous outrages that their savage cruelty hath made the law necessary which enacts, that if one of any clan hath committed a trespass, the rest shall repair the damage, or whoever of them is taken shall suffer death." Some clans are divided into several branches, each of which has its particular surname. According to Colonel Stewart, in his 'Sketches of the Character, Manners, and Present State of the Highlanders of Scotland' (2 vols. 8vo, Edinb. 1822), this surname, peculiar to the branch, is called the *bun sloine*, that is, the genealogical surname, being derived from the Christian name or other designation of the ancestor of the branch. It is the name generally used in common conversation; but every Highlander in writing his signature, and also for the most part when he has to mention another person in writing, uses the name which is common to the whole clan. Most of the Highland noblemen and gentlemen have designations peculiar to them as chiefs of their clans, which in their own country no feudal titles or distinctions, however exalted, are allowed to efface. "Besides his ordinary name and surname," says Sir Walter Scott (note to 'Lady of the Lake,' canto ii.), "which were chiefly used in the intercourse with the Lowlands, every Highland chief had an epithet expressive of his patriarchal dignity as

head of the clan, and which was common to all his predecessors and successors, as Pharaoh to the kings of Egypt, or Arsaces to those of Parthia. This name was usually a patronymic, expressive of his descent from the founder of the family. Thus the Duke of Argyle is called Mac Callum More, or the *Son of Colin the Great*. Sometimes, however, it is derived from armorial distinctions, or the memory of some great feat: thus Lord Seaforth, as chief of the Mackenzies, or Clan-Kennet, bears the epithet of Caber-Fae, or *Buck's Head*, as representative of Colin Fitzgerald, founder of the family, who saved the Scottish king when endangered by a stag."

Although the chieftainship of the clan now descends regularly from father to son or other male heir, there can be little doubt that in ancient times the custom of tanistry prevailed among the Scottish Highlanders, as it did down to a comparatively recent date among the Irish. [BREHON LAWS.]

In Gaelic the individuals of a clan were distinguished from each other by the addition to their own name of that of their fathers; as, Roderick vich Alpin,—that is, son of Alpin; sometimes with the further addition of the name of the grandfather, and the patronymic of the clan was only used to or by strangers.

The common prefix of the Scottish patronymics of clans is *Mac*, that of the Irish *O'*—both signifying son, or at least descendant. But many Irish names also begin with Mac, and some with the synonymous Norman Fitz, the same word with the modern French *fils;* and the *vich*, or *wich*, used as an affix in the same sense by the Russians, is almost identical with the Gaelic. Several of the Scottish clans, however, have surnames in which the common prefix does not appear; as, for instance, the Stewarts, the Gordons, the Robertsons, the Camerons, the Campbells, the Chisholms; and the Clan Chattan, once a very powerful one, had for its head Mackintosh of Mackintosh, captain of Clan Chattan; while the offshoots, still claiming to belong to the clan, took the names of Macgillivray, Macbean, Macqueen, Macphail, Shaw, Gow or Smith, Davidson, Clark, and others. Several of these clans are generally understood not to be of Celtic descent; or rather, the chieftainship has passed by marriage or otherwise into Lowland, Norman, or Saxon families. Indeed, the tribes inhabiting the southern borders of Scotland, whose connection with, and dependence upon their chiefs used to be nearly as complete as that which prevailed in the Highlands (see the Introduction to Scott's 'Mintrelsy of the Scottish Border'), are often also familiarly spoken of as clans. Scott, in the battle canto of Marmion, says:

> "Against them come,
> Of gallant Gordons many a one,
> And many a stubborn Badenoch man,
> And many a rugged border clan,
> With Huntley and with Home."

And the old Scottish statutes, passed in the 16th century for regulating the Borders, speak of "clans having captains and chieftains, on whom they depend, oft-times against the wills of their landlords." "Of course," says Scott, referring to Acts passed in 1574 and 1587, "these laws looked less to the feudal superior than to the chieftain of the name for the restraint of the disorderly tribes; and it is repeatedly enacted, that the head of the clan should be first called upon to deliver those of his sept who should commit any trespass, and that on his failure to do so he should be liable to the injured party in full redress." ('Introduction to Border Minstrelsy.') The essential distinction was, that in the Highland clans, the chief was the head of the family; the whole of the land was his, but only held for the benefit of the whole, which he apportioned as he thought proper; while every individual looked to the chief for maintenance and support. In the Lowlands, and on the Borders, the feudal system prevailed, and property was individualised under certain stipulations for services, civil or military. The difference was shown very remarkably after the rebellions of 1715 and 1745, when, though many of the territorial possessions were forfeited by the chiefs and transferred to other proprietors, the cultivators long continued to consider the old chiefs as the rightful owners, and paid them their tribute accordingly. Also, after the abolition of hereditary jurisdictions in 1748, the great Highland proprietors felt the support of their clans a heavy burden, of which they endeavoured to rid themselves. As the clansmen held no distinct portion of the land, the chief had only to reduce the number of his followers, and he increased the extent of his own possessions. To effect this, considerable severity was used in too many cases, and large numbers of families were evicted from holdings possessed by their ancestors for centuries, to make room for cattle and sheep.

According to Colonel Stewart ('Sketches,' &c., vol. i.), the Gaelic clans of Scotland occupied the counties of Sutherland, Caithness, Ross, Inverness, Cromarty, Nairn, Argyle, Bute, and the Hebrides, with part of Moray, Banff, Stirling, Perth, Dumbarton, Aberdeen, and Angus. He has given a map of Scotland, in which the locality of each clan is marked; and in the second and third sections of his work he describes and examines the system of clanship and its consequences. In his second volume, Appendix Q, is on the Distinctive Patronymics of the Clans. In Robert Patten's 'History of the Rebellion of 1715' (3rd edit., 8vo, Lond. 1745), pp. 191–199, is given 'A List of the most considerable Chiefs in Scotland, and the number of men they can raise, with an account of their disposition for or against the government,' which includes the clans. 'Note," says Patten, "that all the chiefs in Scotland are chiefs of clans, properly so speaking, whether noblemen or gentlemen; but commonly the last only are called the clans, and particularly those of them who live in the north and west Highlands and Isles." Patten's list may be compared with a 'Memorial on the Military strength of the Clans,' which Colonel Stewart has printed in his Appendix C, and which he conceives to have been drawn up a short time before the rebellion of 1745 by President Forbes. Bishop Nicholson has printed in his 'Scottish Historical Library,' from Bell's manuscript 'Introduction to the History of Cumberland,' a catalogue of the chiefs and clans of what was called the west border of the south of Scotland, that in 1547 submitted and gave pledges to Lord Wharton, who had overrun the country, that they would serve the King of England, with the number of followers they could command annexed to the name of each. It has been transferred by Scott to a note on his 'Introduction to the Border Minstrelsy,' along with a list of the east Border chiefs who did homage the same year to the Duke of Somerset, from William Patten's diary of the duke's expedition, originally printed in 1548, and reprinted in Dalyell's 'Fragments of Scottish History.'

The system of clanship, as it subsisted in the Highlands of Scotland, making allowance for the modifications it received from feudalism, in respect of the tenure of property superinduced upon its original purely patriarchal character, is essentially the same state of society that has always prevailed among the wandering Arabs and Tatars of the East. Gibbon's description of the social condition of the Tatars, or, as he calls them, Scythian hordes, in his 26th chapter, would, in great part, suit the state of things in the Highlands, at least as it remained down to the rebellion of 1745. Since that attempt, the measures which the government was induced to take in consequence of it, and, in a still greater degree, the progress made in agricultural and commercial improvement in every part of the Highlands, has reduced the old spirit of clanship to a mere name.

CLARE, NUNS OF THE ORDER OF ST., were instituted by that person at Assisi, in Italy, according to Newcourt, about A.D. 1212. This order was confirmed by Pope Innocent III., and, after him, by Pope Honorius III., A.D. 1223, and was subsequently divided into a stricter and a looser sort. (Newc. 'Repert. Ecclesiast.' vol. i. p. 562.) "St. Clare," says Tanner, "was born in the same town and lived at the same time with St. Francis, and her nuns observing St. Francis's rule, and wearing the same coloured habit with the Franciscan friars, were often called Minoresses, and their house without Aldgate (London), the Minories." They were brought into England by Blanche, queen of Navarre, who was wife to Edmund earl of Lancaster, Leicester, and Derby, under a licence from King Edward I., A.D., 1293. Besides this, there were only three other houses of this order in England, viz. Waterbeche and Denny, in Cambridgeshire, and Brusyard in Suffolk.

CLARENCEUX, the name of one of the provincial kings-of-arms in the Heralds' College. As early as the reign of Edward III. there were two kings-of-arms, who bore the titles of Surroy and Norroy (that is, South and North Kings). Lower ('Curiosities of Heraldry') states that the title of Surroy was changed to Clarenceux by Henry V., who, preferring the herald of his brother Thomas, Duke of Clarence, constable of the army, created him a king-of-arms, and placed the part of England south of the Trent under his care. William Horseley was so created by Henry V., and Roger Lygh by Henry VI. Afterwards it sunk into the office of a herald only, but was again revived in the reign of Edward IV. in favour of William Hawkeslow, who had, however, the west of England only allotted to him as a province. Sir Thomas Holme, knight, who succeeded to the office in 1476, appears to have had first the west, and then the south of England, as the district in which he was to give armorial bearings. This privilege is now exercised by Clarenceux and Norroy concurrently with Garter.

The arms of Clarenceux are, argent, St. George's Cross, upon a chief gules a lion of England crowned with an open crown. The badge is the same, in an escutcheon, crowned with a crown of a king-of-arms, upon a green ground on one side; and on the other, the royal arms crowned upon a white ground, pendent to a gold chain, or simple riband.

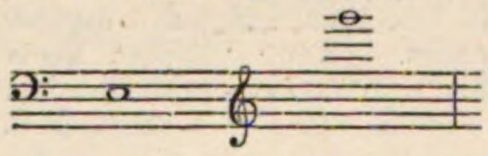
CLARENDON, THE CONSTITUTIONS OF, were certain resolutions, which were in effect ordinances agreed to at a general council of the nobility and prelates assembled by Henry II. at his palace or manor of Clarendon, in Wiltshire, in 1164. These enactments, which the preamble declares to be a record and recognition of the ancient laws and customs of the realm, were sixteen in number, and were intended to define the respective limits of the civil and ecclesiastical jurisdictions, to prevent further encroachments by the clergy, and to abolish the abuses which had arisen from the gradual and increasing usurpations of the pope. (Knight's 'Popular Hist. of England,' vol. i. p. 286.)

CLARET. [WINE.]

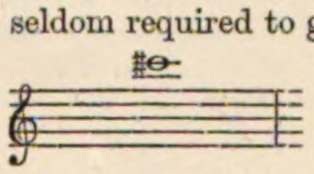
CLARIFICATION, as a manufacturing process, is a mode of clearing or cleansing liquids from certain impurities which affect the colour, odour, taste, or other qualities. According to the nature of the liquid, so does the clarifying agent vary. The process is often called "fining," in reference to the effect in rendering the liquid fine and bright. Some clarifiers act by combining with, or collecting the feculent matter, and subsiding with it to the bottom of the vessel. Others effect a chemical change in the floating impurities, and render them heavy enough to sink to the bottom by their own weight. The

list of clarifiers is considerable, including albumen, gelatine, blood, lime, plaster of Paris, alum, alcohol, sulphuric acid, sugar of lead, sulphate of potash, juices, marl, clay, &c. In clarifying syrups, albumen or white of egg is very useful; seeing that it combines with the impurities when cold, rises with them when heated, and then forms with them a scum which is easily removed. In clarifying the red wines and many kinds of liqueurs and cordials, white of egg is extensively used in a similar way. In clarifying white wines, beer, and cider, and several other beverages, isinglass is used instead of white of egg; the difference depending on certain differences in the chemical affinity of albumen and gelatine for the impurities in the two groups of liquids. To give the "sparkling" effect to liquids in the glass, so much vaunted by the keepers of gin-palaces, salts of lead and of potash are used in a mode not altogether free from poisonous tendencies. In clarifying cider and perry, clay and marl are often used. Coffee is often cleared by isinglass. Heat acts as a clarifier of certain liquids by curdling or coagulating the impurities, rendering them specifically heavier than before, and causing them to sink; and the same effect is produced in a modified way by the action of lime, alum, alcohol, and some of the acids. Bullock's blood is a very useful clarifier, because it is cheap, and because it will act as a substitute both for isinglass and for white of egg. Various modes of clarification will be found noticed under BREWING, CIDER, SUGAR, WINE, &c.

CLARINET, a musical instrument made of wood, similar in shape to the oboë, but of rather larger dimensions, and having a fixed mouthpiece containing a reed, which forms the upper joint of the instrument. It was invented at the commencement of the last century by Denner of Nuremberg, although many years elapsed before it came into general use. The clarinet gives all the sounds of the diatonico-chromatic scale, but the same instrument cannot be used in all the modes, or keys; hence in the orchestra three instruments are employed, of different dimensions, namely, a C, a B, and an A clarinet: that of B is preferred by performers, because it is more mellow in tone, and more manageable as regards fingering. The compass of the clarinet is from E, the third space in the base, to G in altissimo.



But in the orchestra it is seldom required to go higher than C♯ in alt.



The sounds between the lowest note (E) and B♭, the third treble line, are called *Chalumeau* notes, or notes resembling an ancient rustic, instrument so named, which was formed of reed.

BASE CLARINET. This was invented, in 1828, by Streitwolf, an instrument-maker of Göttingen. It is made of wood, and played on in the same manner as the common clarinet. Its compass is four octaves, and it descends to B♭ below the base staff. In length it is two feet eight inches.

CONTRA-BASE CLARINET. The same artist subsequently produced a *double-base* clarinet, which stands in the same relation to wind instruments of wood that the *contra-basso* (double-base) does to stringed instruments, and promises to become very useful in the orchestra. Its form and manner of fingering differ but little from those of the base clarinet: in size it is not larger than the bassoon, and in compass is four notes lower.

In the Great Exhibition of 1851, M. Boehm's instruments attracted attention, and are thus referred to in the Jury Report: "First, he has brought the acoustical proportions of tubes, and the finger holes of wind instruments into correct numbers and measurement, by which means flutes, oboës, clarionets, bassoons, &c., can be theoretically constructed. Secondly, he has invented a mechanism for the keys which gives facility and precision to the execution, and by which the former difficulty of reaching or stopping the holes at great distances, or of large sizes, is now surmounted. As by these means the holes can be made correct in size and position, M. Boehm has acquired not only a perfection in tone and tuning never before attained, but also a great facility in playing in those keys which were hitherto difficult, and defective in sonorousness or intonation."

CLARION, a kind of trumpet, very shrill, and not now in use.

CLAVICHORD (or, improperly, *clarichord*), a musical keyed instrument, much in use up to the middle of the last century, but now only to be met with as a curiosity. Its shape is that of a square pianoforte, though smaller, and the strings are struck, or rather pressed, by brass pins projecting from the further end of the keys. The tones of the Clavichord are rendered exceedingly soft by means of pieces of cloth interwoven with the strings. This softness was its great recommendation in convents, the nuns having thereby been enabled to practise without disturbing others in the dormitory.

CLAY (in Agriculture) is an essential component part of all fertile soils. A soil is clayey in proportion to the alumina [ALUMINA] united to silica of various degrees of fineness which it contains; these are also often united to a portion of carbonate of lime. When the silica is very fine and intimately mixed with alumina, the clay, although stiff in appearance, is fertile in proportion to the humus which it contains, or which is artificially added to it. It then forms that class of rich wheat soils which produce many successive abundant crops without change or manure. It has a strong affinity for water, which prevents the plants that grow in it being injured by drought; and it has a sufficient degree of porousness to allow superfluous moisture to percolate without making it too soft. All that is required for such a soil is a porous substratum of rock or gravel; and where this is not the case, sufficient underdrains must be made to produce the same effect. The clay soils in Britain are not in general of this fertile kind. They are of a compact nature which retains the water; and the various oxides and salts of iron which they contain are mostly injurious to vegetation. Hence they require expensive draining, and manuring, to render them productive. This has made lighter soils, which are more easily worked, to be generally preferred, although naturally less adapted to the growth of wheat; and the mode of cultivation of the light soils has advanced more rapidly towards perfection than that of the clays. Yet the latter will undoubtedly repay the outlay best, when once they are brought to a certain state of improvement. When clay soils are well drained, and when the effect of noxious salts has been removed by liming, burning, and frequent stirring, it will be found that a much smaller quantity of manure will produce a certain return in grass or corn, than on any light soil. The great difficulty is to choose the time when stiff clays are to be worked; and here it may be observed, that ploughing sometimes does more harm than good. When clay is wet, especially in the beginning of summer, and it is ploughed in the regular process of fallowing, the tough moist slice cut out by the plough is set on edge, and the sun bakes it into a hard mass like brick. In this state it is not improved by exposure to the air, which cannot penetrate this hard substance. It would be much better to plough out deep water-furrows with a plough made on purpose, and wait until the moisture is reduced by gradual percolation and evaporation; so that the plough should raise a slice ready to break and crumble as it is turned over. This should be done immediately before winter, and then the frost will so divide and mellow the soil that, provided it be kept free from superfluous water by under-drains and water-furrows, it will have the appearance of the finest mould when worked with the harrows in spring. To plough it again would be to spoil all. It should have received the necessary manuring in autumn, and be ready for the seed to be sown on this pulverised surface. The horses which draw the harrows or the sowing machines should be made to walk in the furrows, which should afterwards be deepened out with the spade, or by a plough constructed for the purpose. A free course and outlet should be formed for all surface water; for no maxim is more true than this, that stiff clays are never injured by a continuance of dry weather, unless they were in a wet state immediately before: the great means, however, of improving clay soils is thorough under-drainage [DRAINAGE]. The dryest clay contains sufficient water to supply the roots of plants for a long time; but wet clay in drying and shrinking destroys the texture of the roots by mechanical pressure. This may be of use when weeds are to be eradicated, and in that case a different mode of proceeding may be recommended; but when good seed is sown, the clay should be in such a state as to crumble under the harrows, and it should not be too moist.

Fallowing for wheat is the old system on clay soils, and continues to be so in nine farms out of ten; but it often happens that in a wet season the whole advantage of the repeated ploughings is entirely lost, the land sown with wheat is neither enriched nor improved by all the tillage bestowed upon it, and is as full of weeds as it was when first broken up from the preceding stubble. The better system is to clean the land well in summer, after it has borne a crop of winter tares, which have been cut green or fed off by sheep in May or June, and to lay it up high and dry for the winter, after having given it the proper liming and manuring; to sow it with oats and grass seeds in spring, keep it in grass as long as is convenient, and break it up in autumn. Wheat may then be sown; or it may have the benefit of another winter's frost, and beans may be drilled or dibbled early in spring. After harvest, the bean stubble may be cleared with harrows or scarifiers, and the seeds allowed to vegetate; the plough will then destroy them. A good crop of wheat may be depended upon after this, if the land is in good heart; if not, it should have been manured for the beans: but if the grass was fed off the preceding year, and the land well managed before, it cannot fail to be in good heart. Clay land will bear a repetition of the same crops much oftener than lighter lands; but every scientific agriculturist knows the advantage of varying the produce as much as possible, making plants of different families succeed each other. The cereal grasses are of one family, which is the reason why wheat, barley, oats, rye-grass, &c., do not succeed so well after each other as after leguminous plants or clover, and that turnips, besides cleaning the land by the repeated hoeings given them, are so good a preparation for corn. A good rotation for stiff clays is yet a desideratum in agriculture; and although we will not affirm that fallows can be entirely dispensed with, we are persuaded that they might be separated by much longer intervals than is usually done. And if advantage is taken of early seasons, at least in the southern parts of the island, most lands may be kept clean by what is called a bastard fallow immediately after harvest, without losing a crop. We will go farther, and assert that instead of three crops in four years,

which is the common method and an improvement on the old system of two crops and a fallow, five might easily be obtained, especially if tares and Trifolium incarnatum are considered as crops. For example: 1. Oats or barley; 2. Clover; 3. Wheat; 4. Trifolium cut in May, and succeeded by spring tares, cabbages, or potatoes. Mangold wurzel is another green crop easily cultivated on clay soils. At all events the trifolium or winter tares may always be had in the year in which the land is to be cleaned by repeated ploughings; as they may be cut early in summer, and leave ample time for the operations.

The great disadvantage of clay soils in a moist climate like that of Great Britain, arises from an excess of water, and the obvious remedy is perfect draining of the subsoil. This is effected by numerous hollow drains judiciously arranged to convey the water to a proper outlet. [DRAINING.]

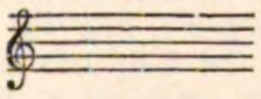
Clay is extensively used in many parts of England to improve light land, by being carried on the surface in considerable quantities, but this is chiefly where it approaches to the quality of marl, by having a considerable portion of calcareous earth in its composition.

The effect of burnt clay as a manure has been highly extolled, and not without some reason in particular situations. Clay by burning alters its nature; it becomes insoluble in water, and loses its attraction for it, becoming more sandy in its texture. The addition of it will thus improve a very strong retentive clay, tempering it and rendering it more porous. To burn clay, it is dug out in lumps and dried; heaps are made of these at regular distances in a field, with a small cavity in the centre, in which dry furze and brushwood are introduced. This being lighted, the fire is allowed to burn very slowly, and the smoke kept in by adding a sod or clod wherever it bursts out. When the heap is once burning, more clay may be added even without being dry, and the combustion goes on without other fuel. It must be so managed as to bake the clay without heating it too much; and when the heaps are cooled and opened the whole should appear pulverised, and of a red colour if oxide of iron exists in the soil. A coat two or three inches thick spread over a field and ploughed in will greatly improve its texture; but sufficient animal or vegetable manure must be added to make it fertile.

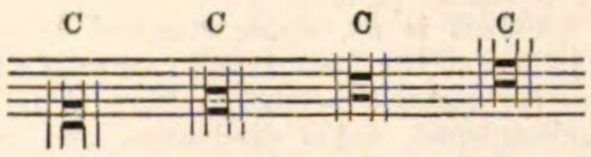
CLAY. Clays are more or less pure compounds of alumina and silic acid. [ALUMINA.]

CLEF (Fr. *clef*, a key), in Music, a character placed at the beginning of the staff, to give names to the lines and spaces, and determine the acuteness or gravity of each note.

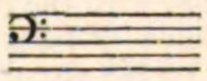
There are three clefs—the *treble*, the *mean* (or C clef), and the *base*. The *Treble Clef* is now only placed on the second line, which it names G.



The *Mean Clef* gives the name of C to any line on which it is placed: it is called the *soprano clef* when placed on the 1st line, the *mezzo-soprano* when on the 2nd, the *alto*, or *contratenor*, or *countertenor*, when on the 3rd, and the *tenor* when on the 4th. By this contrivance the use of numerous ledger lines is avoided, and the music becomes more easy to read.



The *Base Clef* is now placed only on the 4th line, giving it the name of F.



The treble clef is appropriated to female and boys' voices, and to instruments the scales of which run high. Of the four kinds of *mean clef*, the first is used for female and boys' voices; the third and fourth for men's voices, also for the viola, the two higher trombones, and occasionally for the clarinet and violoncello. The *base clef* is appropriated to the lowest male voices, and to instruments the scales of which run deep.

In the 17th century the treble cleff was used on both 1st and 2nd lines, and the base on both 3rd and 4th. The correction of so great an evil was a step towards simplification, and, in 1672, a distinguished mathematician (Thomas Salmon, M.A., of Trinity College, Cambridge) published his plan for a complete amelioration, by the abolition of all clefs, and substituting for them one universal character. The plan was simple and feasible; but it was at once violently, and successfully opposed by the musicians of the day, at the head of whom was Matthew Lock. Thus was strangled in its birth a rational attempt to remove much of the difficulty attending the practice of music. The C clef is now gradually falling into disuse, but we fear that its final rejection is not near at hand, and that a long time will elapse before other desirable reforms in music, calculated to remove many of the impediments to the practice of the art, will be accomplished.

CLEMENTINES is the name given to a collection of decretals and constitutions of Pope Clement V., which was published in 1308 under the title of 'Liber septimus Decretalium,' being the seventh book in order of time of the collection of the decisions and rescripts of the popes on matters of ecclesiastical discipline, and also on matters concerning laymen which then came within the cognisance of the ecclesiastical courts. [CANON LAW.] The first printed editions of the Clementines are those of Mainz, 1460 and 1467, fol.

CLE'PSYDRA (κλεψύδρα, from κλέπτειν, ὕδωρ). Before the invention of pendulum clocks, it was not unusual in astronomical observations to measure time by the flowing of water, upon a principle which, in its most simple application, resembled that of the hour-glass, but which was varied by contrivances for accuracy or ornament. Such an instrument was used, up to the time of Galileo, by Tycho Brahé for instance; but as he does not describe it among his instruments, we may suppose that he hardly considered it to rank among the primary aids of an observer.

The Chaldæans, it is said, divided the zodiac into twelve equal parts, as they supposed, by allowing water to run out of a small orifice during the whole revolution of a star, and dividing the fluid into twelve equal parts, the time answering to each part being taken for that of the passage of a sign over the horizon. The authority for this story is Sextus Empiricus ('Adv. Math.' cap. 21), who adds, that they regularly used the instrument in finding their astrological data, and remarks that the unequal flowing of the water, and the variations of temperature of the atmosphere, would affect the accuracy of their results. Pliny mentions Scipio Nasica as the first who introduced clepsydras into Rome.

We might perhaps object to Sextus Empiricus as an authority on Chaldee usages; but a good presumption of the early use of clepsydras in India is afforded by the arithmetical treatise of Bhascara, written in the 12th century. The prediction at the birth of his daughter, Liliwati, was that she should die unmarried. The father determined to have at least one struggle against the prophecy, and accordingly procured a bridegroom and an astrological determination of a lucky hour. The girl remained in her ornaments near the clepsydra, watching for the moment when she and her parent might set fate at defiance. But at length it was ascertained that the hour was past; and on examining the clock, which should have prevented such a catastrophe, it was found that a pearl had escaped from the daughter's dress and closed the orifice through which the water should have flowed. The father, thus disappointed, said to his unfortunate daughter, "I will write a book of your name, which shall remain to the latest times." The Liliwati accordingly remains, and bids fair to realise the prediction. (Taylor's 'Liliwati,' Bombay, 1816.)

In the account given by Vitruvius ('De Architectura,' lib. ix.), he attributes the invention to Ctesibius; but the instrument described is so complicated that we by no means suppose he intends to assert that this was the first application of the principle even at Alexandria. Some mode of measuring time by the efflux of water, however rude it might be, was used at Athens before the time of Ctesibius, as we see by various passages in Demosthenes. The instrument described by Vitruvius is an elaborate contrivance, which shows the hour, day, month, and sign of the sun. The astronomical clepsydra was rejected by Ptolemy on account of its imperfections, and it is not necessary to follow the moderns through the various modifications under which they have attempted to apply the principle. Such instruments continued to be common, as toys at least, until the middle of the last century.

If we suppose a clepsydra made of a glass cylinder, with a very small orifice at the bottom, and the apparatus being filled with water, the orifice to be opened, the upper surface of the fluid will not descend equally in equal times, according to the notion which Sextus Empiricus attributes to the Chaldæans. If the water be pure, and the orifice very small and unclogged, the following will be the law of descent. Ascertain first the whole time of emptying the cylinder: then in the fraction m of the whole time, the fraction $m\,(2-m)$ of the fluid will have discharged itself; or that same fraction of the whole height will have been fallen through. Thus in one-half the whole time of emptying, $\frac{1}{2}\,(2-\frac{1}{2})$ or $\frac{3}{4}$ of the whole fluid will have been discharged, while in $\frac{1}{4}$ of the whole time $\frac{7}{16}$ of the whole will have been discharged. It is totally out of the question to suppose that the ecliptic was so nearly divided into twelve equal parts as actually was done, by any such imperfect process; though it is not impossible that by keeping the clepsydra constantly full, or very nearly so, equal times may have been estimated by the discharge of equal bulks of fluid. Supposing the cylinder to be kept constantly full, it would discharge its own bulk of fluid in exactly one-half the time in which it would empty itself undisturbed.

CLERGY, a collective term, under which that portion of the population of a country is comprehended who are in holy orders. It is used in contradistinction to *laity*, which comprehends all other persons. Like most ecclesiastical terms, it is of Greek origin, the word κληρικὸς (clericus) having been used in the sense of "appertaining to spiritual persons" by the Greek ecclesiastical writers. From *clericus* comes the word *clerk*, which is still a law term used to designate clergymen, but which appears anciently not to have been confined to persons actually in holy orders, but to have been applied to persons possessed of a certain amount of learning.

The distinction of clergy and laity in the Christian Church may be considered as coeval with the existence of the Church itself; for in the apostolic period there were officers in the Church specially appointed to discharge the duties of pastors or deacons, and even, as many suppose,

bishops or overseers, who had the superintendence of various inferior officers. These persons, though they might not perhaps be entirely relieved from the ordinary duties of life so that they might devote themselves exclusively to their sacred office, yet must necessarily have been nearly so, and it is certain that they were nominated to their offices by some peculiar forms. Very early, however, the distinction became complete. The bishops, priests, and deacons of the Christian Church, each ordained to the office in a manner which it was believed the founders of Christianity appointed, and each supposed to have received a peculiar spiritual grace by devolution from the apostles and from the sacred founder of Christianity himself, soon formed a distinct body of men demanding to be distinguished by some particular appellation.

In all Christian nations the distinction has been recognised by the political authorities, who have allowed certain social privileges or exemptions to the clergy. No inconsiderable share of temporal power, extending not only over the members of their own body, but over the laity, has in most states been conceded to them. In the great German confederation the sovereign power in some of the states was vested in ecclesiastics; while at Rome there has been for many ages an elective monarchy of ecclesiastics, in whom all temporal as well as spiritual authority has been vested.

It is easy to account for the ascendancy of the clergy in the middle ages, and for the acquisition by them of so many valuable exemptions, and so much actual power. They were the best-instructed part of the population. The learning of the age was almost exclusively theirs; and knowledge, if it is not itself power, is at least a means of obtaining it. Besides this, they had a most powerful instrument with which to work upon the ruder minds of the laity, in the power vested in them of alone administering the sacraments of the Church, and of regulating alone under what circumstances those sacraments ought to be administered. This enabled them to win acquiescence in any favourite design, sometimes by gentle influences and sometimes by terror.

The history of almost every country of modern Europe presents instances of struggles between the laity and the clergy for power or privilege. Our limits will not permit us to enter on these, not even on the struggles of this kind in our own country, where they were as determined, and sometimes as fierce, as in any country of Christendom. All power in the clergy of England to erect an authority dangerous to the laity, or to secure to themselves political immunities or privileges inconsistent with the general good, was broken at the Reformation. The clergy of England then became but a fragment of a once great and well-disciplined body, dispersed through the whole of Christendom, which, when acting with common effort and putting forth all its strength, it had been difficult for any single temporal prince to resist with effect.

We shall take from Blackstone a short statement of the privileges which the law of England allows to the clergy. They are but a faint shadow of the privileges which the clergy enjoyed before the Reformation: A clergyman cannot be compelled to serve on a jury, or to appear at a court leet or view of frankpledge. He cannot be compelled to serve the office of bailiff, reeve, constable, or the like. He is privileged from arrest in civil suits while engaged in divine service. He could claim benefit of clergy more than once. [Benefit of Clergy.] Such are the legal exemptions. On the other hand, the clergy cannot now sit in the House of Commons, nor can they engage in any kind of trade, though sometimes clergymen have been brought within the scope of the bankrupt laws. It was held, even, that they could not legally be shareholders in a commercial company, but this restriction was removed in 1838 by the 1 Vict. c. 10. By the law as it stood previously to the 57 Geo. III. c. 99, they were not allowed to take lands to farm; but by that Act (s. 2) they are permitted (with the consent of the bishop of the diocese) to farm lands to the extent of 80 acres for a term not exceeding seven years.

The clergy meet by delegates in convocation at the beginning of every new parliament; and they have courts in which jurisdiction is exercised touching ecclesiastical affairs, and, till 1858, all causes testamentary or matrimonial, as well as those where the church's censures are directed against particular classes of offenders. To them also belongs the whole ecclesiastical revenue, with divers fees or customary payments, and to them also the whole regulation of the terms of admission to their order.

The three great classes of the English clergy are the bishops, priests, and deacons. To be admitted into each of those classes requires a peculiar ordination. This distinction is of an entirely different kind from that which arises out of office or appointment. Of this kind of distinction there is in the English clergy the archbishop, the bishop, the dean and canons of a conventual or collegiate church (some of the canons being in many instances invested with particular characters, as precentors, succentors, and the like), the archdeacon, the rural dean, dean of some church whose constitution is peculiar, the rector, the vicar, the curate in some chapels called parochial, the minister in some newly founded chapel, whether a chapel of ease or what is called a proprietary chapel, assistant ministers to aid the vicar or the rector in some churches of ancient foundation, and, finally, a body of persons called curates, who are engaged by the incumbents of benefices to assist them in the performance of their duties, but who are not dismissible at the caprice of the incumbent, nor left by law without a claim upon a certain portion of the profits of the benefice.

These are the various offices in which the clergy of the Church of England are distributed. As the subject is of importance, and seems to be but imperfectly understood, we shall here briefly notice wherein lies the distinction of *rector*, *vicar*, and *curate*, to one of which belongs nearly every individual of the English clergy.

For this purpose, England must be regarded as divided into somewhat more than 17,150 small districts (returns were not made of a few), varying in extent, called parishes or parochial districts, according to the census of 1851. Each of these parishes or districts must be regarded as having its church, and one person (or in some instances more than one) who ministers divine ordinances in that church. This person, whose proper designation is *persona ecclesiæ*, enjoys of common right the tithe of the parish, and has usually a house and glebe belonging to his benefice. When this, the original arrangement, is undisturbed, we have a parish and its *rector*. But in the times before the Reformation it was a very common practice of the *patrons*, or persons who had the right to nominate the persona or rector, to give that right to some monastery or community of religious. Such community, instead of nominating some person as rector, would profess to discharge the duties of the parish by sending from time to time one of its own body to perform those duties, or by engaging some person at a stipend settled by themselves, to perform the duties, they taking the tithe and other profits of the benefice to the use of their house. Some few of the ancient parishes of England have thus been entirely stripped of their tithe and the other property out of which a resident minister might have been supported; but in nearly every instance the bishops interfered, and compelled the religious houses to settle some determinate share of the profits of those benefices upon a clergyman who should be fixed in the parish upon the nomination of the monastery, but no more removable than if he had really been the persona or rector. This person is called the *vicar*, *vicarius*, that is, one who stands in the place of another; and the other whom the vicar represented was in this instance the religious community, in whom vested the two characters of patron and rector.

The provision made for the support of the vicar varied in different parishes, but it was usually some fixed portion of the tithe with the oblations. The agreement, however, which was between the religious community and the bishop was arbitrary, and hence it is that we find the vicars so variously endowed. At the Reformation, whatever interest the religious communities possessed in the parishes was seized by the crown, and has since been either retained by it, or, what has usually been the case, has been sold to private persons, whence arises the class of the *lay impropriators*, who are, in fact, the rectors of the parish, the performance of the spiritual duties devolving on the vicar. *Curates* who are not merely assistants to a rector or a vicar are, in general, incumbents of churches in which no vicarage was ever ordained, or incumbents of chapels of foundation later than the era of the foundation of parishes, and endowed by the special bounty of particular persons.

CLERGY, BENEFIT OF. [Benefit of Clergy.]

CLERK IN ORDERS. [Clergy.]

CLERK OF ASSIZE is an officer attached to each circuit, who accompanies the judges at the assizes, and performs all the ministerial acts of the court. He issues subpœnas, orders, writs, and other processes; draws indictments; takes discharges, and respites recognizances; files informations, affidavits, and other instruments, enters every *nolle prosequi*, records all the proceedings of the court, and enters its judgments. He is associated with the judges in the commissions to take assizes; and he is restrained by statute 33 Hen. VIII. c. 24, from being counsel for any person on his circuit. He was formerly paid by the fees charged upon the several official acts performed by him; but now, by the 15 & 16 Vict. c. 73, and 18 & 19 Vict. c. 126, clerks of assize and their officers are paid by salary, the fees receivable in respect of their duties being accounted for by them to the government.

CLERK OF THE CROWN IN CHANCERY, is an officer of the crown in attendance upon both Houses of Parliament, and upon the great seal. In the House of Lords he makes out and issues all writs of summons to peers, writs for the attendance of the judges, commissions to summon and prorogue Parliament, and to pass bills; and he attends at the table of the House to read the titles of bills whenever the royal assent is given to them. He receives and has the custody of the returns of the representative peers of Scotland, and certifies them to the House; and makes out and issues writs for the election of representative peers of Ireland and their writs of summons. He is the registrar of the Lord High Steward's Court for state trials and for the trial of peers; and he is also registrar of the Coronation Court of Claims.

In connexion with the House of Commons, he makes out and issues all writs for the election of members in Great Britain (those for Ireland being issued by the clerk of the crown in Ireland); gives notice thereof to the secretary-for-war, under Act 8 Geo. II. c. 30, for the removal of troops from the place of election; receives and retains the custody of all returns to Parliament for the United Kingdom; notifies each return in the 'London Gazette,' registers it in the books of his office, and certifies it to the House. By Act 6 & 7 Vict. c. 18, he

has the custody of all poll-books taken at elections, and is required to register them, to give office copies or an inspection of them to all parties applying, and to prove them before election committees. He attends all election committees with the returns of members; and when a return is to be amended in consequence of the determination of an election committee, he attends at the table of the House to amend it.

He is also an officer of the lord chancellor, as the holder of the great seal; and in this department makes out all patents, commissions, warrants, appointments, or other instruments that pass the great seal, except patents which are passed in the Patent Office. He administers the oaths of office to the lord chancellor, the judges, the serjeants-at-law, and all other law officers, and records the same in the books of his office. For these several duties he receives a salary of 1000*l.* a year. (7 & 8 Vict. c. 77; 'Parl. Report,' 455, Sess. 1844.)

The office of the Clerk of the Crown is commonly called the Crown Office; but there is also an office in the Court of Queen's Bench called the Crown side, or Crown office of the Court, of which there is a master and other officers.

CLERK OF THE HOUSE OF COMMONS, the chief officer of that House, is appointed by the crown for life, by letters patent. Upon entering office he is sworn before the lord chancellor "to make true entries, remembrances, and journals of the things done and passed in the House of Commons;" in which duties he is aided by the clerk-assistant and second clerk-assistant. These three officers are more commonly known as "clerks at the table." The chief clerk signs all orders of the House, endorses the bills, and reads whatever is required to be read in the proceedings of the House. He is also responsible for the execution of all the official business of the House, which is under his superintendence. In the patent he is styled "Under Clerk of the Parliaments to attend upon the Commons;" whence it is inferred that on the separation of the two Houses, the under-clerk of the Parliaments went with the Commons, leaving the clerk of the Parliaments in the Upper House.

(Hatsell, *Precedents*, vol. ii. p. 251; May, *Law, &c. of Parliament;* 4 & 5 Will. IV. c. 70.)

CLERK OF THE PARLIAMENTS is the chief ministerial officer of the House of Lords. His duties (which are executed by the clerk-assistant and additional clerk-assistant) are to take minutes of all the proceedings, orders, and judgments of the House; to sign all orders, to endorse bills, to swear witnesses at the bar, to wait upon the sovereign when the royal assent is given to bills, and to take the commands of the crown upon them; and to signify the royal assent in all cases, whether given by the sovereign in person or by commission. He is also sent occasionally as a messenger from the Lords to the Commons. Besides these and other special duties, he is charged with the general superintendence of the official establishment of the House of Lords. He is paid out of the Lords' Fee Fund, of which no account is ever given.

(May, *Law, &c. of Parliament.*)

CLERK OF THE PEACE is an officer attached to every county or division of a county, city, borough, or other place in which quarter-sessions are held; being the ministerial officer of the court of quarter-sessions. He is appointed by the *Custos Rotulorum* of the county, and holds his appointment so long as he shall well demean himself. In case of misbehaviour the justices in sessions, on receiving a complaint in writing, may suspend or discharge him, after an examination and proof thereof openly in the sessions; in which case the *Custos Rotulorum* is required to appoint another person residing within the county or division. In case of his refusal or neglect to make this appointment, before the next general quarter-sessions, the justices in sessions may appoint a clerk of the peace. (1 Will. III. c. 21, s. 6.) The *Custos Rotulorum* may not sell the office or take any bond or assurance to receive any reward, directly or indirectly, for the appointment, on pain of both himself and the Clerk of the Peace being disabled from holding their respective offices, and forfeiting double the value of the consideration, to any one who shall sue them. (Id. s. 8.) To give effect to this provision, before the Clerk of the Peace enters upon the execution of his duties he takes an oath that he has not paid anything for his nomination.

The Clerk of the Peace may execute the duties of his office either personally, or by a sufficient deputy approved by the *Custos Rotulorum.* He or his deputy must be constantly in attendance upon the court of quarter-sessions. He gives notice of its being holden or adjourned; issues its various processes; records its proceedings; and performs all the ministerial acts required to give effect to its decisions. During the sitting of the court, he reads all acts directed to be read in sessions; calls the jurors, and parties under recognizance; presents the bills to the grand jury and receives them again; arraigns prisoners, administers oaths, and receives and records verdicts. Whenever prosecutors decline any other professional assistance, he is required to draw bills of indictment.

In addition to these general duties he has other special duties imposed upon him by different statutes, in regard to the summoning of juries, the appointment of sheriffs and under-sheriffs, the custody of inclosure awards, orders for stopping up highways, documents required to be deposited with him under Acts of Parliament and standing orders of the Houses of Parliament, and other matters.

The Clerk of the Peace is paid by fees or by salary, by order of a secretary of state, on the recommendation of the court of quarter-sessions, or (in boroughs) of the town council. (14 & 15 Vict. c. 55. By the 57 Geo. III. c. 91, and the 11 & 12 Vict. c. 43, the justices of the peace for the county, and the town council in boroughs, are authorised to settle a table of fees, to be approved by the secretary of state, which may not be exceeded by the clerk of the peace, under a penalty. If he take more than is authorised by such table of fees, he will also be liable to be proceeded against at common law for extortion, and to be removed from his office by the court of quarter sessions. The sessions cannot, however, compel the payment of these fees by summary process, nor detain the parties until they be paid, but the Clerk of the Peace is left to his remedy by action.

(Dickinson, *Quarter Sessions;* Burn, *Justice of the Peace.*)

CLERKS AND SERVANTS. [SERVANTS.]

CLIENT (Cliens), apparently derived from the verb *cluo*, "to listen to," "to obey;" though Dr. Ihne thinks that the derivation of the word from *colere* (*cliens quasi colonus*) has a certain value, as serving to mark out what he maintains, in opposition to Niebuhr, to be the fact that the true clients supported themselves through their connexion with agriculture. From the origin of the institutions of ancient Rome, there appears to have existed the relation of patronage (*patronatus*) and clientship (*clientela*). Romulus, the founder of Rome, was, according to tradition, the founder of this institution. Ihne, however, endeavours to maintain that the clientage was not an institution belonging exclusively to Rome, called into life by the whim of a king, or the co-operation of peculiar causes, but that it existed among all Italian people, Sabines, Samnites, and Etrurians. (See 'Researches into the History of the Roman Constitution,' by W. Ihne.) The cliens may perhaps be compared with the vassal of the middle ages. Being a man generally without possessions of his own, the client in such case received from some patrician a part of his domains, as a precarious and revocable possession. The client was under the protection of the patrician of whom he held his lands, who in respect of such a relation was named patron (*patronus*), that is, father of the family, as *matrona* was the mother, "in relation to their children and domestics, and to their dependents, their clients." (Niebuhr.) It was formerly the opinion that every plebeian was also a client to some patrician; but Niebuhr, in speaking with reference to the proposition that "the patrons and clients made up the whole Roman people," affirms that the "assertion is one the validity of which is not to be questioned, save when it is carried too far. If we do not acknowledge that the plebeians were free, and overlook the nature of the commonalty, it is both false and destructive of historical truth; but it is perfectly true if applied to the period before the commonalty was formed, when all the Romans were comprised in the original tribes, each in his own house." In the later times of the republic the clients probably, for the most part, consisted of *liberti* and their descendants. Between the patron and his client there existed mutual rights and obligations. The patron was bound to take his client under his paternal protection; to help him in case of want and difficulty, and even to assist him with his property; to plead for him and defend him in suits. The client on his part was bound in obedience to his patron, as a child to his parent; to promote his honour, assist him in all affairs; to give his vote for him when he sought any office, to ransom him when he was made prisoner and not able to pay the ransom himself; and to contribute to the portion of the patron's daughter. The patron succeeded to his property when the client died without heirs; which was also the law of the twelve tables in the case of a freedman (Ulpian., Fragm., tit. xxvii. § i., and tit. xxix. § i.) who died intestate and left no heir (*suus heres*). Patron and client were not permitted to sue at law, or give evidence against one another; and so sacred were the duties of the patron towards his client, that whoever trespassed against them was guilty of treason, and devoted to the infernal gods (outlawed), so that any one might kill him with impunity.

Originally patricians only could be patrons; but when, in the later times of the republic, the plebeians had access to all the honours of the state, clients also were attached to them.

The terms *patronus* and *libertus*, or even *patronus* and *cliens*, as used in the later years of the republic, and under the emperors, cannot be considered as expressing the same relation as the terms *patronus* and *cliens* in the early ages of Rome, though the latter relation was probably derived from the earlier one. When a foreigner who came to reside at Rome selected a patron, which, if not the universal, was the common practice, he did no more than what every foreigner who settles in a strange country often finds it his interest to do. The existing relationship at Rome between patron and client facilitated the formation of similar relations between foreigners and Roman citizens; the foreigner thus obtained a protector and perhaps a friend, and the Roman increased his influence by becoming the patron of men of letters and of genius. (See Cicero 'pro Archia,' c. 3, and 'De Oratore,' i. 39, on the 'Jus Applicationis;' Dionysius ii. 9, 10. See also Niebuhr, vol. i., p. 322, edition 1851, &c., and the references in the notes.

As a Roman client was defended in law-suits by his patron, the word client is used in modern times for a party who is represented by a hired counsellor or solicitor.

CLIMATE is a word which has been transplanted from the Greek into every modern European language. The Greek word κλίμα (from

κλίνω, to incline) seems originally to have been used to express the apparent inclination of the heavens towards the horizon; and it was afterwards used as a technical term in astronomy and geography to indicate generally the distance on the celestial sphere, as well as on the terrestrial globe, from the equinoctial line towards the poles.

The plural of this word, κλίματα (climata), however, was used in a somewhat different sense, and answered, in some degree, to our parallels of latitude. The Greeks supposed the celestial sphere to be divided into girdles or zones, parallel to the equator, and surrounding the whole sphere. They then endeavoured to ascertain through what stars the parallel circles forming the boundary-lines of such a zone were to be drawn, and what stars fell within the zone. The same division they afterwards applied to the terrestrial globe, ascertaining first the places through which the boundary-lines of the zones ran, and then determining at what distance from them the intermediate places were situated. These zones were called climata, or climates, and were used by them as we now use the degrees of latitude.

These climata of the Greek geographers however did not always embrace an equal number of degrees of latitude. The principle of the division into zones was the length of the longest days; and a difference of half an hour generally determined the breadth of one of these climates. For instance, one of the boundary-lines of a zone would run through the places in which the longest day had thirteen hours, and the other through those in which it was thirteen hours and a half. This was sufficient for their purposes in those parts of the globe where there was only a small number of places the position of which had been determined. But it was not sufficient for those parts where the number of places determined was greater, as in Greece and the adjacent countries. Here they gave a less width to the climate, allowing only a quarter of an hour for the difference between the boundary-lines of a climate. For instance, the southern boundary-line of such a zone would run through the places whose longest day was fourteen hours, and the northern through those in which it was fourteen hours and a quarter.

The greater exactness of modern astronomical observations has rendered this division of the globe useless, and we have substituted for it the notation by degrees of latitude. The Greeks, of course, made use of these climata as we do the degrees of latitude, to indicate in a general way the comparative temperature which a country enjoys by reason of its smaller or greater distance from the equator. Modern nations have adopted the term climate, but with somewhat enlarged signification. Climate, with us, not only implies the greater or less degree of heat which a country is subject to, but also the quantity of moisture in its atmosphere, and, in general, all the phenomena which affect vegetation, and render a country a fit abode for men and animals.

Heat and moisture, properly speaking, constitute climate; but the latter is dependent on the former, while that itself varies originally according to distance from the equator, and height above the level of the sea, the results of both co-ordinates being themselves subject to variation from other causes. The other phenomena, such as winds, electricity, &c., affect these constituents of climate; but they require a separate consideration, as modifiers of it, according to the view which we take of the subject.

We may observe, that those places where a high temperature is combined with a great quantity of moisture, are the most fertile, and display the most luxuriant vegetation, provided the surface is not formed of naked rocks; but even the solid rocks will in time yield to the combined influence of heat and moisture, and be clothed with a rich vegetation; though, on the other hand, in temperate climates at least, certain igneous rocks, of which those of the extinct volcanic region of Central France are examples, remain undecomposed and almost devoid of vegetable covering for an indefinite period. And on the Peak of Teneriffe, the lavas resulting from countless ages of volcanic action, have not sensibly disintegrated; here, however, the atmosphere is arid, and the effective clouds are far below.

The latitude of the place is generally considered as the principal circumstance in determining its temperature. It is laid down as a fact, that countries lying under the equinoctial line or close to it are subject to the greatest comparative heat, which constantly decreases with the increase of distance from that line. This general rule must be admitted to be true for all the countries which lie between the tropics and the pole; but it may be questioned how far it is true of the countries within the tropics. A glance at a globe or sphere shows that the sun at the end of the first month after the equinox has already advanced 12° of latitude towards the tropic; but in the second month it traverses only 8°. At the end of the second month it is consequently 20° from the equator. There remain therefore only 3½° to be traversed in the third month. The sun recedes from the tropic in the same way. It passes the first month through 3½°; the second through 8°; and the third through 12° of latitude. Hence it is evident, that at all places between 20° and 23½° of latitude, the solar rays during two months fall at noon either perpendicularly, or at an angle which deviates from a right angle only by 3½° at most. If we take a place intermediate between 20° and 23½° of latitude, the solar rays must fall on it during two whole months, either perpendicularly, or in a direction still less removed from the perpendicular than in the former case. On the other hand, when the sun passes the equator, two places on which the vertical rays of the sun fall on two consecutive days are nearly ½° of latitude distant from one another; and a place situated exactly under the equator has only during six days the sun as near its zenith as the above-mentioned places near the tropics have it during two whole months. We might therefore presume, that the summer heat of the latter position must be much greater than that of places near the equator. This degree of temperature must be increased by the greater length of the longest days, which near the tropic are 13½ hours; but at the equator are always of the length of 12 hours.

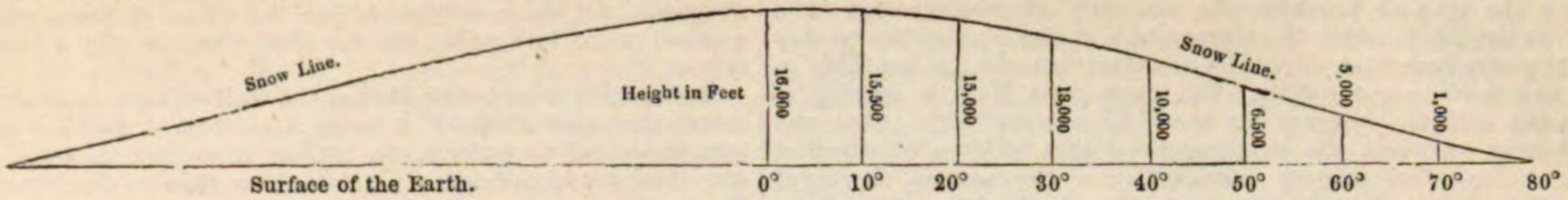
This reasoning is not contradicted by experience. The countries in which the greatest degree of heat is experienced in the northern hemisphere, lie near the tropic of Cancer. They are the countries on the banks of the Senegal, the Tehama of Arabia, and Mekran in Beloochistan; tropical Africa, however, being the hottest region of all. The ancients were not unacquainted with these facts; and one of their most ingenious inquirers, Posidonius, was so struck by the peculiarities of the countries near the tropic, that, for the purposes of physical geography, he wished to consider them as forming a particular zone, different both from the equatorial zone and the temperate zone, and separating these two in the form of a narrow belt. He observes that these countries are characterised by the aridity and sterility of their soil, and that no rain falls there, while the regions nearer the equator, having abundance of rain and moisture, are exceedingly fertile. (Strabo, ii.)

Though the mean temperature differs greatly in countries lying in different degrees of latitude, the most intense degree of heat which is experienced in all countries between the equator and 60° of latitude is nearly equal. The thermometer rises almost every year at St. Petersburg to above 90°; and it is observed that even on the coast of Guinea, and on the banks of the Senegal, it rarely exceeds 95°. There are certain instances in which it has attained a much higher degree. Dr. Coulter observed it at 140° on the banks of the Rio Colorado (32° 30′ N. lat.); but such exceptions must be ascribed to local circumstances, especially to the reflection of the solar rays from an arid and sandy surface.

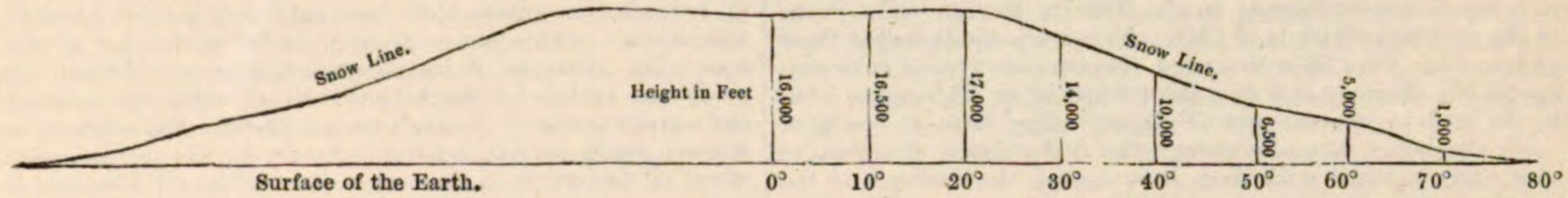
The general rule, derived from geographical position, as to the distribution of heat over the surface of the earth, is subject to many exceptions, arising from local circumstances. But none of these local circumstances probably affect it so much as the elevation of the surface. It is a well-known fact, that near the tropics and the equator there are mountains which, owing to their great elevation, are covered with snow all the year round. The heat experienced in a given place not only depends on the greater or less obliquity of the rays of the sun, but also on the greater or less column of the atmosphere. The column of air is greatest on the surface of the sea and in such countries as are nearly on a level with it. The higher we rise above this level the more the air is rarefied, and the degree of heat due to the solar rays decreases. Thus we at last arrive at an elevation where the heat, even under the equator, is insufficient to melt the snow. As the density of the air and the intensity of the heat continually decrease as we rise higher, some attempts have been made to determine the law of the decreasing temperature. Alexander von Humboldt, who made a great number of observations on the steep declivities of the Andes near the equator, came to the conclusion that the thermometer of Fahrenheit descends one degree when we rise 343 feet above the level of the sea, and one degree for every 343 feet more. Thus the thermometer may be used to determine in a rough way the heights of mountains or of elevated plains. The calculations of Humboldt, however, are only founded on observations made in the intertropical countries, and it is supposed that the same law will not be applicable in all its extent to places situated without the tropics. Dr. Joseph Dalton Hooker, F.R.S., from contemporaneous observations made in East Nepal, N. lat. about 28°, altitude 10,385 feet, and at Calcutta, found 1° Fahr. for every 309 feet of elevation.

As already observed, at a certain height above the surface of the sea the heat caused by the solar rays is too feeble to melt the snow and ice. This limit has been called the snow-line, or line of perpetual snow, or line of perpetual congelation. This snow-line does not occur in all places at the same elevation, but is dependent on the mean temperature in summer. In warm countries it is consequently found at a much higher elevation than in cold countries. It has been ascertained by numerous observations, that in the Andes of South America, near the equator, the summit of a mountain rising to less than 16,000 feet does not attain the snow-line; but in Norway, in 76° of lat., mountains with an elevation of 2900 to 3350 feet are always covered with snow, as Professor James Forbes has shown; and in the southern hemisphere the line of perpetual snow in the Straits of Magalhaens (52° S. lat.) is about 3390 feet above the sea. Nowhere in the Northern Hemisphere does the snow-line descend to the level of the sea, the intensity of the summer heat during the period of perpetual day effectually thawing the soil, though only to a trifling depth, and raising upon its surface a certain amount of brief vegetation suitable for the support of arctic animals. In the Southern Hemisphere, however, the temperature of which, as a whole, is greatly inferior to that of the Northern, the snow-line attains the level of the sea itself (according to Sir James C. Ross, as cited by Professor Forbes) in the Antarctic regions, at a latitude between 67° and 71°, under which, in Norway, forests still grow, and even corn in some sheltered places. Numerous observations made on

the mountains of Europe, combined with those made by Humboldt in South America, suggested the idea that the snow-line forms a regular curve (north and south) on the surface of the earth, in the following way :—



But more recent observation has shown that we are still very imperfectly acquainted with the laws by which this important boundary-line in the atmosphere is determined. Mr. Pentland ascertained, by a great number of observations, that in the Andes of South America, between 14° and 17° S. lat., the snow-line does not occur on mountains below the height of 17,000 feet. Pœppig, in traversing the Andes, near 11° S. lat., found that here also they were free from snow at an elevation several hundred feet higher than the snow-line under the equator. Agreeably to these facts, and to a generalisation of Von Buch which includes them,—that the temperature of the summer months determines the elevation of perennial snow,—the snow-line would thus be represented, not by a curve of continuous curvature, but by one of this form :—



These observations on the elevation of the snow-line above the level of the sea, are however only applicable to mountains which rise with a steep ascent, and are not contiguous to table-lands. High table-lands have a higher temperature than isolated mountains of the same height. Humboldt observed that the elevated plains on which the towns of Bogotà, Popayan, Quito, and Mexico are built, have a much warmer climate than they would have if elevation above the sea were the only element that determined the temperature when the latitude is given. In comparing the mean temperature of these plains with that of the adjacent coast, he found that the thermometer, instead of descending one degree for every 343 feet, had only sunk so much for every 400 feet of perpendicular elevation. He thinks that this difference may be accounted for by supposing that the temperature of the atmosphere, under these circumstances, is considerably raised by the reflection and radiation of the sun's rays from a plain of considerable extent. This supposition is confirmed by the circumstance of the different heights at which the snow-line occurs on the southern and northern declivities of the Himalaya Mountains. On the southern declivity of that range, which rises rapidly from the low plains of the Ganges, Mr. Webb found the snow-line at an elevation of about 13,000 feet, corresponding pretty well with its latitude (about 30°); but on the northern declivity, which is about a degree farther north, the snow-line ascends to 16,000 feet, an elevation which corresponds to that found under the equator. On this side, however, the range, though very steep, does not descend to a low country, but terminates in an immense plain, the surface of which is about 10,000 feet above the level of the sea. The great difference between the elevation at which the snow-line occurs on the two declivities is thus partly to be explained by the difference in the height of the plains which are respectively contiguous to them; but in part, also, by the excessive dryness of the climate of Tibet, on the northern side of the range.

Captain Gerard gives from 18,000 to 19,000 feet as the altitude of the level of perpetual snow on the mountains of the Tibetan table-land north of the upper valleys of the Indus and Sutlej. From the more recent observations of Dr. Hooker, given in his 'Himalayan Journals,' it appears that on the Donkia Mountain (23,176 feet high), in Sikkim, 28° N. lat. very nearly, the elevation of the snow-level is not less than 19,000 feet; and he is of opinion, that 40 miles further north (in Tibet), its altitude is probably 20,000 feet.

This subject will be resumed in the article Snow, Perennial. Its relations to that of climate in general have been thus summarily stated by Prof. Forbes, in his work on Norway, pp. 205–206: "The occurrence of perpetual snow at a certain height above the sea, in even the warmest regions in the globe, has in all ages excited the curiosity of geographers and naturalists. Regarded at first as a very simple indication of the depression of temperature as we ascend in the atmosphere, it has been carefully studied and applied (often erroneously) to the determination of climate. Closer examination has shown that the presence of perennial snow—in other words, a predominance of all the causes tending to its accumulation over those which tend to its waste or fusion—is, indeed, a very complicated fact, and cannot be taken as the simple expression of any one of the elements of climate. The snow-line is far from having invariably a mean temperature of 32°, as was at one time supposed. Under the equator it is about 35° [in the Sikkim Himalaya probably 20°, according to Dr. Hooker]; in the Alps and Pyrenees about 25°; and in latitude 68°, in Norway, it is (according to Von Buch) only 21°. . . . . The mean temperature of the snow-line diminishes towards the Pole, because, for a given mean temperature of the whole year, the summer is far hotter in proportion. Also, places at which the temperature of the summer is low, are those which have a moderated or coast climate; but there also the fall of rain and snow is most abundant, whilst in excessive or continental climates the precipitations are comparatively small."

Temperature is still affected by such circumstances and phenomena as the nature of the soil, the prevailing winds, the quantity of moisture, the electrical state of the atmosphere, and the physical character of the adjacent countries and seas.

Where the soil has been to a great extent cleared and brought into cultivation, the air is much drier and warmer in summer than in those tracts which, for want of cultivation, remain covered with swamps and marshy grounds. This, according to Darby, is the case in the cultivated parts of the United States, in which he asserts, contrary to the vulgar notion, that in the cleared and cultivated tracts the summer temperature has been raised, and that of winter diminished. The latter circumstance would seem a natural consequence of clearing the surface and exposing it during the winter months to the full influence of the north-west winds. In fact, as the country becomes more open, the range of the thermometer increases. As far as we know, no attempts have been made to ascertain to what amount such differences in the soil affect the temperature of a country, though our knowledge seems to be quite sufficient to assign the reasons for the existence of such a difference.

The effect of the winds on the temperature of a place is still more obvious. It is a common observation, that the thermometer is more or less raised or depressed by every change of the wind. But there is a great difference in this respect between the lower and higher altitudes. In the former, a change of wind rarely raises or depresses the thermometer more than a few degrees; while in the higher latitudes it frequently happens that in a few hours a change of ten or twelve degrees, and even more, takes place. Captain Scoresby mentions an instance of this near the polar ice. On a sudden veering of the wind to the north, the thermometer fell, in sixteen hours, 34 degrees, from + 32° to − 2°. But changes as great as this, so far as such changes are measured merely by degrees, occur in the United States of North America, at some distance from the Atlantic. Again, even in the lower latitudes, the change of the wind has a greater effect on the temperature on high table-lands than on low plains. Mr. Dunn states, that on the table-land of Guatemala, it sometimes, though very rarely, happens, that during the period of the northern winds a cold current produces a difference of 20 degrees in a few hours. A similar phenomenon has never been observed on the low coasts between the tropics.

It is a very common observation, that both cold and heat are more intense when the sky is clear than when it is overcast with clouds. Hence it may be inferred that countries, whose atmosphere is more loaded with clouds and vapours than that of others in the same parallel, must have warmer winters and colder summers. This difference is observed all over the world, and from it partly arises the difference of climate in maritime and continental countries. It is even observed in countries which are at no great distance from one another, as in England and Holland. In England, the mean temperature of the summer and winter is said not to differ more than about 22 degrees of Fahrenheit, while on the opposite shores of Holland it amounts to 27 degrees, the winters there being a little colder and the summers somewhat warmer than with us. On this, however, we must observe that there is no very great propriety in comparing the mean temperature of a country of the form and position of England with one of the form and position of Holland. If two points under the same latitude, and both near the sea, were taken on the opposite coasts of England and Holland, the difference, whatever it might be, would obviously be owing to the difference in the tracts of country contiguous to the respective places, to the winds, and to the hygrometrical state of the atmosphere. Before any safe conclusion could be drawn, all these conditions should be known. There appears no doubt, however, that the difference in the mean temperature of the two seasons increases as we proceed farther east in the European continent; and it

is equally certain that it depends mainly on the hygrometrical state of the atmosphere, which again in a great degree depends on the winds.

Since the time of Franklin, the attention of observers has been drawn to the effects which the temperature of one country has on that of contiguous countries. In calm weather that effect is probably so small as not to be perceptible. But whenever a wind is stirring, it brings the colder or warmer air from one country to the other, and thus lowers or raises the temperature of that country to which it blows. This effect is very perceptible on the eastern shores of England, with respect to the easterly winds. In the latter part of the spring or early in summer, these winds, before they reach England, pass over the still chilled and damp surface of the great plain of Northern Germany, and blight the already advanced vegetation of our eastern counties. On the contrary, in autumn the same winds pass over a sandy soil, which during the summer has acquired a considerable degree of heat, and the air brought over by them is warm enough to raise the thermometer several degrees. A still more remarkable instance is mentioned by Pœppig, in his 'Travels through Chile, Peru,' &c. In the southern districts of Chile, the eastern winds, called there los Puelches, when they blow in spring (September) are so cold that they depress the thermometer in a short time 15 or 18 degrees; but towards the end of the summer (February) they raise it nearly as much. He attributes naturally enough the first effect to the chain of the Andes being covered with deep snow during the spring, and the second to the high temperature to which the air upon the sandy plains of the Pampas of Buenos Ayres is raised during the summer months.

Considering the great effect which the temperature of countries contiguous to one another exercises on their respective climates, we may presume that a similar effect is produced by seas similarly situated. This has been long ago shown by the observations made on the regular change of the land and sea breezes in warm countries, and by the explanation of this phenomenon, which is obvious and simple. But it has only been recently ascertained, that the proportion between the temperature of the sea-water and the atmosphere above it is not everywhere the same, but that in some parts the sea-water is warmer than in others under the same latitude. Now the temperature of the water must in some degree affect the temperature of the atmosphere, and this atmosphere, when brought into contact with the air of the land by the winds, must produce a change in its temperature. This consideration may sufficiently explain why the countries round the Mediterranean enjoy a much milder climate than all others placed under the same parallel. It is now ascertained that the temperature of the water of the Mediterranean Sea is from 4° to 5° higher than that of the Atlantic in the same parallel. This may perhaps lead us to the explanation of the greatest anomaly of climate which exists on the globe—we allude to the great difference of temperature existing between the western countries of Europe and all the other countries of the globe lying in the same parallel.

Those who had the first opportunity of observing the difference in temperature between western Europe and the eastern coasts of North America were natives of western Europe, and of course they considered the climate of their own countries as constituting the rule, and that of North America as the exception. They accordingly attempted to explain this phenomenon by a reference to some peculiarities which characterise North America as a continent, such as the increase of its breadth towards the poles, the stretching out of the continent so far to the north, its large rivers and lakes, &c. But when the temperature of Asia and the eastern countries of Europe was ascertained by observation, it appeared that their temperature differed as much, and in many places still more, from that of the western countries of Europe than North America does. The climate of America may therefore be considered as the rule, and that of Europe the exception. Still the question remains, to what peculiar circumstance it is owing that the temperature of Western Europe differs from that of America and the countries lying farther east in the same latitude by 8° or 10°.

We venture to offer an opinion that the Gulf Stream is the most active, if not the only, cause in producing this difference. This remarkable current stretches across the Atlantic between Cape Hatteras, in North America (35° N. lat.), and the Azores, forming nearly in the middle of the Northern Atlantic a lake of warm water, which, according to the calculations of Major Rennell, is not inferior to the Mediterranean in extent. The temperature of its water is from 3° to 10° higher than that of the surrounding sea. The temperature of the superincumbent air is likewise several degrees higher than it is farther to the west and south, but less so when compared with those portions of the Atlantic which lie farther to the east and north-east. We think that this last difference is due to the strong gales which are almost continually experienced in navigating the Gulf Stream, but more especially on its borders; they blow most frequently from the south-west and west. Winds blowing from these quarters are by far the most prevalent in the Northern Atlantic, and it is observed that even on the coast of Western Europe they still preserve the character impressed upon them by the gales of the Gulf Stream. They do not blow equably like the other winds, but in abrupt gusts, with short intervals of calm. These winds appear to waft the warmer air of the Gulf Stream over the whole of the coasts of Western Europe from Cape Finisterre as far as North Cape; they even penetrate through the wide gate between the Harz mountains and the Scandinavian ranges into the recess of the Baltic, and their effects extend to the very plains of Russia, where they are met by the prevailing north-eastern winds and stopped. All the countries within the range of these winds enjoy a much more favourable climate than those to which they do not extend.

It may here be objected, that as the Gulf Stream approaches much nearer the coast of North America than that of Europe, and as the temperature of its water is also highest there, such an effect as is here described should rather apply to the New than to the Old Continent. But, in the first place, the Gulf Stream along the coast of America is of comparatively inconsiderable width, being opposite Charleston only from 60 to 63 miles across: and, secondly, its waters in their whole course along that coast lose very little of their temperature. At Cape Hatteras, after a course of 900 miles, the stream has only lost 3° Fahr. of warmth. From this point it turns to the east, and the decrease of temperature begins to be somewhat greater. Yet even opposite the great bank of Newfoundland, after a course of 1300 miles through 15° of latitude, its waters have lost only 5° Fahr. of warmth, and the temperature in this part is from 8° to 10° above that of the adjacent seas. The decrease of temperature begins to be most considerable about the middle of the Atlantic. Now, when we consider that on the eastern coasts of North America likewise the western and south-western winds prevail, it follows that by far the greatest portion of the warm air derived from the evaporation of the Gulf Stream must come to those countries which lie to the leeward of these winds. The parts of North America, however, to the east of the Appallachian range, seem also to feel in some degree the heated air of the Gulf Stream; since it has been proved by Darby that they have a temperature by several degrees higher than the parts in the same latitude to the west of that range.

Another remarkable difference in temperature occurs in the countries which form the most southern part of the American continent. Humboldt has compared a considerable number of observations, from which it appears that south of 48° the mean temperature of South America is from 12° to 18° lower than that of those parts which lie in the same latitude in other meridians. North of 48° S. lat. this difference is still considerable, but it gradually diminishes as we approach the tropics. At about 30° it seems to disappear entirely. The greater cold of the antarctic regions had been recognised before. It was conjectured by Captain Cook to be due to the existence of a large tract of land between 70° S. lat. and the pole. This was singularly confirmed by the investigations of Sir James C. Ross in 1841, who found Victoria Land, extending from 71° to 79° S. lat., skirted by a great barrier of ice; and the land itself, ranging in altitude from 4000 to 14,000 feet, entirely covered with snow.

Many persons suppose that the peculiar form of South America, which narrows towards the south, and stretches out in the form of an acute angle, may be sufficient to explain this phenomenon; but this diminution of the surface of the land should rather have an opposite effect, and the true cause we have no doubt is to be found in the fact last stated.

There are other circumstances, besides those enumerated, which affect the general temperature, but their influence is confined to small tracts. Thus the temperature of some places is considerably raised or lowered from their being situated on the southern or northern declivity of a high range, or in a narrow valley, or from their being entirely or in a great part surrounded by water. Even the existence of large forests has some influence on the temperature of contiguous places. But as the influence of such circumstances is local, it may be sufficient here to indicate it.

The circumstances which tend to increase or to depress the general temperature of a country being so numerous, and their effect (in producing which several of them often co-operate) being in some instances very great, it often happens that the actual temperature of a country differs considerably from that which might be inferred from the latitude in which it lies. To show therefore what countries, situated under different parallels, have an equal or nearly equal temperature, the isothermal lines, or lines of equal temperature, have been introduced. [ISOTHERMAL LINES.]

The second chief constituent of climate, the moisture of the air, appears under the form of rain, vapour, fog, and dew. We shall limit our observations to rain, in this article.

There are extensive tracts of this globe on which a drop of rain is never known to fall, or only at intervals of many years, and then only in small quantities. These countries are always found near the tropics, sometimes extending on both sides of these circles, but often only on the side towards the poles, which circumstance is probably to be ascribed to local peculiarities. These countries may be said to run like two belts round the globe, dividing the countries on each side of the equinoctial line from the temperate zone, as Posidonius very correctly stated. It is only where mountain-ranges exist, that these belts of rainless regions are interrupted. Beginning with the Old Continent, we find in Africa the Sahara or Great Desert, on the southern borders of which the rains cease at about 16° N. lat. and on the north begin at about 28°. Proceeding farther east, the southern rains cease in the countries on the banks of the Nile between 18° and 19°, and the northern begin between 27° and 28°. Passing the Gulf of Arabia we find the Tehama, or low coast of Arabia, which is destitute of rains; but we do not yet

know how far to the south or north the rainless region extends. The high table-land which backs this coast on the east is said to have annually some rain, but we have no account of this region on which we can rely; it may be that it owes this advantage to local peculiarities, especially to its elevation. Farther east the rainless region extends through Meckran, a province of Beloochistan, the desert of that country, and over the delta of the Indus. Here it appears not to comprehend more than 4° of latitude. From this point it turns to the north-east and extends to 30° N. lat., comprehending the Indian desert to the very base of the Himalaya mountains. Behind this range extends the high table-land of Tibet, which also has no rain. But at the eastern extremity of the Old Continent, in China, there is no rainless region, which may perhaps be owing to the circumstance that all the parts of China between 22° and 30° N. lat. are traversed by the high mountain chains of the Nan-ling and Yoo-ling, and consist of a continual succession of ridges and valleys.

That part of Southern Africa, on the shores of the Atlantic, which extends to the north of the Gareep, or Orange River (between 24° and 28° S. lat.), is said to be a sandy desert, with little or no rain. Towards the Indian Ocean, Africa is traversed by several mountain-ranges, and consequently has there a somewhat moister climate. Australia also appears to be subject to the same disadvantages. The long droughts, sometimes continuing several years together, which occur in New South Wales, indicate that a great portion of Australia must be reckoned among the countries which are entirely or nearly destitute of rain.

In America the rainless region near the tropics is less distinctly marked, probably on account of the comparatively narrow width of that continent near the tropics, and other local peculiarities; yet such a region exists in both hemispheres. In the northern it seems to occupy the coast of the Gulf of Mexico, between 24° and 26°, and to extend westward, comprehending the arid plains of Monterey and Chihuàhua, till it reaches the northern portion of the Sierra Madre Mountains, whose northern extremity it surrounds. It then stretches along both banks of the Rio Gila to the Gulf of California, where it however does not terminate, as the peninsula of California has no rain north of 23°. The countries of South America, near the tropic of Capricorn, rise suddenly from the Atlantic Ocean to a considerable height, and take the form of high table-land, traversed by mountain ridges. These parts of course are not without rain; but nearly midway between both oceans the country sinks considerably lower, and the Grand Chaco or Great Desert occurs, in which rain seems to be very rare. This extensive plain is divided from the Atlantic by a mountainous country, and from the Pacific by the high range of the Andes. In both these mountainous regions rains are frequent; but on the coast of the Pacific, though it presents a very uneven surface, not a drop of rain is known to fall all the year round between 23° and 27° S. lat. This barren tract consists of the Chilese department of Copiapò and the Bolivian province of Atacama.

These two belts of rainless regions, which on the land are frequently narrowed or interrupted by local circumstances, have a more distinct character on the ocean. Rain seldom falls within the range of the trade winds, except on their very borders, both towards the region of the calms and towards that of the variable winds. [CALMS.]

Between the two belts formed by the rainless regions are situated those countries which are subject to the equatorial rains. The ocean also has these rains in a small degree in those parts which constitute the region of calms. Here the phenomena of the atmosphere succeed one another with great regularity. The sun rises in a cloudless sky; towards noon some faint clouds appear near the horizon, which rapidly increase in extent and density, and are soon followed by thunder and violent gusts of wind, accompanied by heavy rains of short duration; towards evening the clouds disappear, and the sun sets in a serene sky of a deep blue hue. It does not appear that this state of the weather is at all affected by the seasons.

Those parts of both continents which lie on each side of the equator between the rainless regions have the greatest quantity of rain, and this occurs at certain periods of the year, whence these rains are called periodical rains. The season of the rains depends on the position of the sun. It begins some time before the sun reaches the zenith of a place, and continues for some time after it has passed it; hence the rainy season varies with the difference of latitude. Though the observations which are requisite to determine this point are far from being sufficiently numerous, it would appear that those countries which are near the equator are never for many days altogether without rain, and that there the rainy season, which occurs when the sun passes over the zenith, is only distinguished from the other parts of the year by a greater continuance and a greater abundance of the rains. In the countries more than 5° of lat. distant from the equator, the dry and wet seasons are distinctly marked. The rains begin either immediately or not many days after the sun in its progress towards such a place has passed the equator. They are heaviest when the sun approaches the zenith of the place, after which they continue with less abundance for an equal or even a longer time. In general the rains are more abundant in the first than in the second half of the season.

Countries that lie between 5° and 10° of lat. have commonly two rainy and two dry seasons. The greater rainy season occurs when the sun in its progress to the nearest tropic passes over the zenith, and lasts from three to four months. The less rainy season occurs when the sun on its return from the nearest tropic approaches the parallel of the place. The rains then last only from six weeks to two months, and are much less abundant and continual. Countries more than 10° or 12° from the equator have only one rainy and one dry season; the first begins when the sun approaches the nearest tropic, and ends some time after, when, in its course from the tropic, it has passed the parallel of the place. It lasts from four to six months. Such is the course of the rainy and dry seasons in these countries, when their regularity is not disturbed by local circumstances, which sometimes effect considerable changes. The most remarkable deviation from this order occurs in India, where the period of the rainy and dry season is not regulated by the position of the sun, but by the change of the monsoons.

The periodical rains differ from the variable rains, which occur in the countries that lie without the tropics, not only in the greater regularity of the time at which they fall, but also in their abundance. The quantity of water which pours down between the tropics in one hour is often greater than that which falls in these latitudes in three or four hours. There is however an erroneous opinion prevalent respecting these rains: it is generally supposed that they continue for many days without interruption, but this is not the case: a day in which the rains fall without interruption from morning to evening is of much rarer occurrence between the tropics than with us; the sun usually rises in a cloudless sky: two hours before noon the clouds begin to appear, and at noon the rains set in. They then frequently pour down in torrents for four or five hours; but towards sunset they cease, the clouds suddenly disappear, and not a drop descends during the whole night. As the abundant rains, especially when the rainy season sets in, frequently cover the level and low country a foot deeper with water, the atmosphere of such tracts is continually loaded with vapours and exhalations during that period, which render the stars invisible at night, and are doubtless a principal cause of the unhealthiness of those countries.

The parts which lie between the rainless regions and the pole are subject to the variable rains. There is not a single day in the year in which it has not rained, or may not rain, and the rains are perhaps as common in the night as in the day. There are certainly differences, both in the quantity and in the time of the rains in these countries; but these differences can only be ascertained by comparing long sets of exact observations; and such exact observations are still wanting, except for the western parts of Europe. Comparing these observations, one would suppose that the countries south of 45° N. lat., with few exceptions, have also a kind of rainy and dry season, the former occurring in autumn and winter, and the latter in spring and summer. In summer frequently two or three months pass without a single drop of rain falling. In the countries north of 45° such a difference is not observed; there the greatest quantity of rain seems to fall in the summer, except in England, where the spring and summer are the driest seasons. The quantity of rain however decreases as we advance from the shores of the Atlantic to the inland parts of the European continent. The rains become again more abundant when we reach the plains of Eastern Europe, near Petersburg and Moscow, which may perhaps be owing to the circumstance, that here the winds proceeding from the Gulf Stream meet those which blow from the Ural Mountains and the great sandy deserts. These rules, derived from observations made in Europe, will probably not hold good for other parts of the globe, because the temperature of Europe forms, as we have observed, a great anomaly. Accordingly we find that meteorological observations made in the United States are far from confirming these rules. [ISOTHERMAL LINES, METEOROLOGY, RAIN, REFRIGERATION OF THE GLOBE, SNOW, TEMPERATURE, WEATHER.]

CLIMAX (κλίμαξ, a step or ladder), commonly called a figure of rhetoric, but properly only an artifice of style; for a figure or trope is a use of words in some other than their natural or literal sense. In accordance with the primary meaning of the Greek word, a climax in composition is a mode of expression by which the writer mounts, as it were, from one clause to another, as if he were climbing a series of steps. In other words, each clause expresses a higher degree of that which is stated in the preceding clause. The three words which Suetonius records to have been uttered on the occasion of one of his victories by Julius Cæsar—"Veni, vidi, vici," form a climax. The following sentence addressed by Cicero to Cataline is another: "Nihil agis, nihil moliris, nihil cogitas, quod ego non audiam, non videam, planeque sentiam." (You do nothing, you attempt nothing, you conceive nothing, which I do not hear, which I do not see, nay, which I do not even feel.) "A gradual progress from small to great," observes Lord Kames ('Elements of Criticism,' chap. iv.), "is not less remarkable in figurative than in real grandeur or elevation. Every one must have observed the delightful effect of a number of thoughts or sentiments, artfully disposed like an ascending series, and making impressions deeper and deeper; such disposition of members in a period, is termed a *climax*." In another passage he makes an attempt to explain the effect asserted to be thus produced. "If a number of objects of the same kind," he says (chap. xviii. § 2), "differing only in size, are to be ranged along a straight line, the most agreeable order to the eye is that of an increasing series; in surveying a number of such objects, beginning at the least, and proceeding to

greater and greater, the mind swells gradually with the successive objects, and in its progress has a very sensible pleasure. Precisely for the same reason, words expressive of such objects ought to be placed in the same order." The effect of a climax would seem to be more simply accounted for by the consideration of the state into which the mind of a reader or hearer is necessarily thrown by an emphatic assertion in a vehement or impassioned discourse; he naturally expects that the next assertion, if another is to follow, will involve something still stronger or more exciting—that it will constitute some addition to what has been already said—else why should it be uttered at all? He is gratified, of course, when this expectation is fulfilled, and would be the reverse if it were not. The latter effect is produced by what is called an anti-climax, the slight shock of the disappointment occasioned by which is sometimes, in suitable circumstances, made available to produce the emotion of the ludicrous. Lord Kames (chap. xviii. § 1) reckons what he calls a *climax in sound* and defines to be the "order of words or members gradually increasing in length," as one of the beauties of language. One example of this which he gives is the following from Cicero: "Quicum quæstor fueram; quicum me sors consuetudoque majorum; quicum me deorum hominumque judicium conjunxerat." When the climax in sense and the climax in sound coincide in the same passage, he afterwards observes (chap. xviii. § 3), "the concordance of sound and sense is delightful; the reader is conscious not only of pleasure from the two climaxes separately, but of an additional pleasure from their concordance, and from finding the sense so justly imitated by the sound." We may remark that, although an anti-climax, except to produce a ludicrous effect, must always be regarded as a stumble in composition, and is therefore to be avoided, a climax is the favourite ornament of an artificial and mouthing style of rhetoric. A natural writer will commonly come out with the strongest thing he has to say at once, instead of cautiously advancing to it by this sort of measured dance. (For an example of climax from Demosthenes, see 'Demetrius Phal.' Περὶ Ἑρμηνείας.)

CLIO. [MUSES.]

CLIPPER. This word has become so thoroughly engrafted on our nautical vocabulary, that it claims some attention. It is used to designate a new construction of vessels, built rather for speed than for their carrying qualities, and seems to have originated principally in the north of England, and also in Scotland, where a spirited ship-builder ventured, a few years since, to leave the trodden path, and enter upon a new field of enterprise, by adding to the mercantile marine specimens of naval architecture which at once met with public approval; and from the increased speed of those vessels, they were styled "Aberdeen Clippers."

Mathematical science has been tortured to produce a knowledge of correct principles as applicable to the water-lines of a ship [NAVAL ARCHITECTURE], and the forms of vessels have undergone changes accordingly. [WAVE PRINCIPLE.] Perhaps few single circumstances have operated more powerfully or more rapidly in producing these changes than the arrival in the Solent of the celebrated yacht called the America, in 1851. Her peculiarities were striking. In the first place, all the old seamen's notions of a "good full bow and long floor to catch her in a sea-way," were at once confounded by the plain fact that here was a vessel built with her greatest beam abaft the centre of the ship, which would outsail all our fastest yachts with the greatest ease; and whereas in ordinary vessels they required considerable buoyancy forward to raise them in a sea-way, this, in the American clipper, was effected by the placing of the centre of gravity of the whole mass further aft than usual. And again: a good deep fore-foot had been deemed essential to any vessel intended to have weatherly qualities. In the America, however, this was very much diminished, and such weatherly powers were obtained by means of a deepness of keel. And further, the qualification of being quick in stays, which our vague notions had generally attributed to the action and adjustment of the sails alone, was in the America secured by her having a very deep heel, so that she drew very considerably more water aft than forward. But that which seemed most to astonish the nautical world was the form of the water-line under the vessel's counter. In the America, this water-line altogether may be compared to the shape of the longitudinal section of a pear, the stalk of which might represent the bowsprit. It is even difficult to this day for ordinary sailors to understand the theory of the principle on which her sailing qualities depended.

Those who have been accustomed to combine, in their ideas of necessary form for swiftness, the cod's head and mackarel's tail, saw at once in the America those assumed requirements disputed; and even the more thoughtful, remembering the experiments of Colonel Beaufoy (who demonstrated that a taper spar, with truncated ends, required less power to force it through the water with the large end foremost than with the small end), were at a loss to account for the success obtained by the America, with such apparently heavy after lines. But a little consideration will remove all doubt; nor need we, in reality, relinquish the good old axioms which attributed speed in vessels to the having a good entry, and the avoidance of dead water. The good entry of the present time, as certainly introduced into England by the America, may be said to consist in a considerable lengthening of the proportions of the bow, which throws the heel of the fore-mast further from the fore-foot, and thus eases a vessel in a sea-way. (In some of our coasting schooners and brigs of the old school, the fore-mast seems almost to step on the fore-foot, and the same defect may be seen in several of our old line-of-battle ships.) With regard to the after-lines, or, as usually called, the run of a ship, such care is taken to prevent her from dragging dead water after her, from faulty deliverance of the fluid displaced, that we have now in our mercantile marine a large number of fast-sailing ships, built professedly with regard to these special qualifications, and to which the term clipper is given by universal consent. But the chief popular error (which still influences many, and is a bar to the full development of greater perfection in the lines of a ship) consists in the taking of the form of the water-surface line only (as many did with the America), and pronouncing a run defective or otherwise, according as this line appeared rounded or straight: but it must be remembered, that the progress of a fast-sailing ship, and the consequent displacement of water, creates a sort of imperfect vacuum, into which the fluid from the bends of the ship rushes; and the more nearly straight these lines can be made, the more easily is this vacuum annihilated, and dead water prevented: in other words, the faster the ship will sail. From the above it will be apparent that water may be delivered along the after part of a ship's hull from every possible direction, and speed may therefore be looked for as attainable by not only the sharp deep Ryde wherry, but the flat-bottomed *dish-like* galliot. The former delivers the water horizontally, the latter vertically. The question of mere speed, and the power of being weatherly, are of a totally different nature.

To show that there is room for improvement in some of our most noted ships, the following occurred to the writer of this: One of the fastest of the Liverpool Australian clipper-ships was, two or three years since, in a dry dock. On examination of her lines, a remark escaped him, that she would sail better stern foremost. On her return voyage, it chanced that peculiarity of weather and unavoidable circumstances prolonged her homeward passage to above 100 days. Prompted by curiosity to examine her copper and water-line *when afloat*, the writer, as she lay in the Mersey, had an excellent opportunity, and found that from the stem-piece all along the side of the ship, the copper appeared almost burnished with the friction of the water during so long a continuous and rapid propulsion; but just under the mizen-chains appeared the "plague-spot," where, instead of the brightness seen elsewhere towards the fore-part of the ship, the copper began to show tarnish, until, within a space of certainly not more than six feet, the copper was quite green and corroded,—indisputably indicating a diminution of friction, or a hollowness; and consequently (as further search proved), a serious amount of unnecessary dead water, and hindrance to speed, in this still fine and handsome well-known clipper. Hollow lines forward are said to contribute towards speed, but it is a question if they are admissible abaft.

The word clipper is only applied to vessels engaged in mercantile enterprise, and is not to be confounded with the term yacht. [YACHT.]

CLOA'CÆ; large arched drains, or sewers, formed under the streets of some ancient Roman cities. The most remarkable were the cloacæ of Rome, large portions of which still remain in excellent repair. These cloacæ are doubtless of high antiquity, and tradition assigns their origin to the time of the first Tarquin. (Livy, i. 38.) According to Livy (v. 55), the chief subterranean passages originally followed the lines of the streets and public places; but in the hurry of rebuilding the city after the Gallic invasion, the old lines of streets were neglected, and the houses were often built across the drains.

The cloacæ of Rome consisted of several branches, which ran in the low part between the hills: these branches fell into one very large arched drain, constructed of solid blocks of stone, called the Cloaca Maxima, said to have been built by Tarquinius Superbus (Livy, i. 56), and repaired, in later times, by Cato the Censor and his colleague in office. A portion of this cloaca is visible near the arch of Janus. It was formerly continued towards the Tiber, passing by the Corinthian peripteral temple, called the Temple of Vesta, close to which it terminated in the Tiber, at a point believed to be the Pulchrum Littus, so called from the sides of the river having a walled embankment with steps. The arched drain of the Cloaca Maxima is fifteen feet wide and thirty high (these dimensions include the masonry), with three arches in contact one within another: in some parts there are raised paths along the sides of the cloaca, and in the walls are stone brackets to support the ends of the waste pipes of the fountains. The three arches are still in excellent order, and exhibit not only a thorough knowledge of the construction of the arch, but admirable workmanship. Niebuhr says that the innermost vault forms a semicircle 18 palms (of 8·79 inches each) in width, and of the same height. This vault is inclosed within a second, and this again within a third. The stone employed, called peperino, is a greenish stone with black specks. The blocks are $7\frac{1}{2}$ palms long and $4\frac{1}{6}$ high. The same writer is of opinion that the Cloaca Maxima was only constructed to drain the Velabrum and the valley of the Circus Maximus. ('Hist. of Rome.') In the year 1742 a part of the Cloaca Maxima was discovered in the Forum, at the depth of thirty feet from the surface, constructed in a similar manner to the part which is seen near the temple of Janus (Nardini, p. 210, lib. v., cap. vii., regio viii.) Niebuhr, on the authority of Ficaroni, says it was constructed of travertino stone, or tufa, and he thinks it of greater antiquity than the peperino construction. Smaller drains of wood or clay intersected the city in every direction, and communicated with the Cloaca Maxima, and drain-pipes or tubes carried off the refuse of

the houses. Until the formation of the sewers of London, there existed no cloacæ or drains for a city which could be compared with the cloacæ of Rome. [SEWERS.]

The maintenance of the Roman cloacæ was originally the business of the censors, but afterwards belonged to the ædiles; Agrippa, during his ædileship, made numerous large cloacæ, of which Pliny (xxxvi. 15) has spoken in terms of unbounded admiration. The emperors created officers called curatores cloacarum. The city of Pompeii had cloacæ on a smaller scale, and from the mention made by Diodorus of the cloacæ (ὑπόνομοι) of Agrigentum there can be little doubt that other cities were provided with cloacæ, though of course on a much smaller and less complete scale than Rome.

CLOCK AND WATCH-MAKING. There is a close connecting-link, or rather series of links, between the mechanism of a pocket-watch, a chronometer, a spring-clock, and a pendulum-clock, rendering it convenient to treat of them all under one heading. We shall therefore at once refer the reader to the article HOROLOGY, for the requisite information on these matters.

CLOISTER, from the Anglo-Saxon clauſtꝛ or cluſtep, adopted from the Latin *claustrum*, a place inclosed or shut up. The term is more particularly applied to the covered walk or inclosure which was the usual appendage of our ancient monasteries and collegiate establishments, where the inmates met to converse and take exercise, or frequented for the purpose of study. It was also very commonly used as a place of sepulture for the members of the establishment. The cloister was always attached to the church, and was usually carried round the sides of a quadrangle; see the plan of Durham Cathedral in the article CHURCH. In a more general sense, cloister is used for a monastery at large, whether of monks or nuns, the inmates being inclosed or shut up from the world. The German word "kloster" retains this original signification.

CLOUD, in meteorology, a mass of aqueous vapour condensed into the visible form, in which it consists of globular particles of water, excessively minute, and probably not vesicular or hollow, the entire congeries of which, when of a certain magnitude and density of aggregation, normally reflects white light, but is translucent and colourless for very small thicknesses, and from its powerful absorptive action upon light in greater but still moderate thicknesses is absolutely opaque. It may float in the atmosphere, or rest on the surface of the earth; but in all cases it is a portion of the aqueous vapour in the atmosphere, separated by reduction of temperature, however effected. When resting on the earth's surface, or produced or existing very near it, that which, when seen above, is termed *cloud*, is familiarly known as *mist* or *fog*; the latter term being also applied to the same object when modified by certain circumstances and additions. The consideration of the mode of production, appearance, disappearance, and results of the clouds, is an important branch of meteorological knowledge, which we shall introduce to our readers by a review of their more obvious phenomena, as made subjects of scientific investigation.

Science is indebted to the veteran meteorologist, Mr. Luke Howard, F.R.S., the author of 'The Climate of London,' and other works, and now (1859) vice-president of the British Meteorological Society, for a classification and nomenclature enabling observers to fix their ideas of the proverbially ever-varying and fleeting forms presented by the condensed vapours of the atmosphere, which, after the experience of more than half a century, in the hands of men of science, meteorologists and physicists, of every country and of every grade, has been found universally applicable, in all climates, and in all general or local conditions of the atmosphere, and has scarcely been found susceptible either of change or of addition. This classification and nomenclature was first enunciated in an essay read by Mr. Howard before the Askesian Society (already noticed in this Cyclopædia, BIOG. DIV., PEPYS, WILLIAM HASLEDINE; PHILLIPS, RICHARD; and PHILLIPS, WILLIAM), in the session 1802-1803, and originally published in the 'Philosophical Magazine,' first series, vols. xvi. xvii., 1803, 1804, in the form of a paper, containing the substance of that essay, 'On the Modifications of clouds, and on the Principles of their Production, Suspension, and Destruction.' It was reproduced, with some changes not affecting the nomenclature, in Rees's 'Cyclopædia,' in the article 'Cloud,' of which Mr. Howard was the author; and this was reprinted by William Nicholson, in his well-known 'Journal of Natural Philosophy,' &c., 8vo series, for September, 1811, vol. xxx., p. 35-62.

At the end of the second volume of his work on the 'Climate of London,' published in 1820, Mr. Howard gave the 'Terminology of Clouds,' &c., as an extract from his paper; and in the second edition of that work, published in 1833, he republished the paper itself, which, with some notes, forms a portion of the introductory matter to the first volume, having also been separately printed and published in the preceding year. From this is derived the following view of the subject.

Mr. Howard applies "to the various forms of suspended water" the term "modifications of cloud;" and after stating that "there are three simple and distinct modifications, in any one of which the aggregate of minute drops, called a cloud, *may be formed, increase to its greatest extent, and finally decrease and disappear*," he proceeds to describe substantially in the following terms, first the simple, and then the intermediate and compound modifications, prefacing the description

of each by its definition. To the characters of the first three modifications, some particulars derived from Sir John F. W. Herschel, are here added. The primary modifications are thus defined and described:—

Cirrus. Parallel, flexuous, or diverging fibres, extensible by increase in any or all directions. They are the earliest appearance after serene weather, being first indicated by a few threads pencilled as it were on the sky. These increase in length, and new ones are at the same time added to them. The first formed threads serve as stems to support numerous branches, which in their turn give rise to others. The upward direction of the fibres or tufts of this cloud has been found to be a decided indication of the condensation of the aqueous vapour in the air preceding rain; their downward direction indicates evaporation and fair weather. The cirrus, of all the modifications of cloud, has the least density of aggregation, the greatest elevation, and the greatest variety of extent and direction.

The name of mare's-tails, by which cirri are commonly known, describes their aspect well. Their filamentous structure clearly indicates them as in the act of originating from the production of visible vapour from the union of aërial currents of different temperatures running parallel to each other. From their great elevation it is more than probable that their particles are frozen, and of course crystalline, and that to this constitution it is owing that halos, coronæ, and other optical appearances, referable (as originally inferred, we believe, by Dr. T. Young) to reflections and refractions in ice-crystals, appear almost invariably in cirrus and in its derivative forms, especially the cirro-stratus. Cirrus is said to be often a precursor of windy weather. Some interesting, but at present obscure, relations between this modification of cloud and the POLAR LIGHTS will be alluded to in the article on that subject.

Cumulus. Convex or conical heaps, increasing upward from a horizontal base. Clouds in this modification are commonly of the most dense texture; they are generally formed in the lower nubiferous atmosphere, and move along with the current which is next the earth. A small irregular spot first appears, and is, as it were, the nucleus on which the increase takes place. The lower surface continues irregularly plane, while the upper rises into conical or hemispherical heaps, which may afterwards continue long nearly of the same bulk, or rapidly grow to the size of mountains. [Prof. James Forbes observed from the summit of the Jungfrau, in the Bernese Alps, a single "magnificent cumulus-headed cloud," reaching apparently from the valley below to at least 2000 feet above the mountain, so that its vertical thickness or height must have been at least 10,000 feet, or about two miles.] In the former case cumuli are usually numerous and near together, in the latter comparatively few and distant; but whether there are few or many, their bases lie nearly in one horizontal plane, and their increase upward is somewhat proportionate to the extent of base. The cumulus of fair weather has a moderate elevation and extent, and a well-defined rounded surface. Previous to rain it increases more rapidly, appears lower in the atmosphere, and with its surface full of loose fleeces or protuberances, it being now *efflorescent*, as it were, on the great scale.

A particular account of the production of this modification, by Sir John Herschel, will be found in the general views of the formation and nature of clouds given in the sequel of this article.

Stratus. A widely extended, continuous, horizontal sheet, increasing from below upward. It is of intermediate density of aggregation, but is the lowest of clouds, its inferior surface commonly resting on the earth or on water. Contrary to the cumulus, which may be considered as belonging to the *day*, this is properly the cloud of *night*; the time of its first appearance being about sunset. It comprehends all those creeping mists which in calm evenings ascend in spreading sheets (like an inundation) from the bottom of valleys and the surface of lakes, rivers, and other pieces of water, to cover the surrounding country. Its duration is frequently through the night. On the return of the sun the level surface of this cloud begins to put on the appearance of cumulus, the whole at the same time separating from the ground. The continuity is next destroyed, and the cloud ascends and evaporates, or passes off with the morning breeze. This change has been long experienced as a prognostic of fair weather, and indeed there is none more serene than that which is ushered in by it.

When the dew-point is attained at some definite altitude above the ground, stratus is also formed there; of which Sir J. Herschel records an instance in which the cloud was extended in the air at the rate of 300 miles in an hour, in the direction of the depression of temperature caused by the setting of the sun.

The two intermediate modifications are:—

Cirro-cumulus. Small, well-defined, roundish masses, in close horizontal arrangement or contact. The cirrus having continued for some time increasing or stationary, usually passes either into the cirro-cumulus or the cirro-stratus, at the same time descending to a lower station in the atmosphere. It is formed from a cirrus, or from a number of small separate cirri, by the fibres collapsing as it were, and passing into small roundish masses, in which the texture of the cirrus is no longer discernible, although they still retain somewhat of the same relative arrangement. This modification forms a very beautiful sky, sometimes exhibiting numerous distinct beds of these small connected clouds, floating at different altitudes. It is frequent

in summer, and is attendant on warm and dry weather. It may either evaporate or gradually become cirrus or cirro-stratus.

Cirro-stratus. Horizontal or slightly inclined masses, attenuated towards a part or the whole of their circumference, bent downward, or undulated; separate, or in groups consisting of small clouds having these characters. This cloud appears to result from the subsidence of the fibres of the cirrus to a horizontal position, at the same time that they approach towards each other laterally. The form and relative position, when seen in the distance, frequently give the idea of shoals of fish. Yet in this, as in other instances, the structure must be attended to rather than the form, which varies much, presenting at times the appearance of parallel bars, or interwoven streaks like the grain of polished wood. It is thick in the middle and attenuated towards the edge. The cirro-stratus precedes wind and rain, the near or distant approach of which may sometimes be estimated from its greater or less abundance and permanence; it is almost always to be seen in the intervals of storms. Sometimes this and the cirro-cumulus appear together in the sky, and even alternate with each other in the same cloud, when the different evolutions which take place are a curious spectacle, and a judgment may be formed of the weather likely to ensue by observing which modification prevails at last. The cirro-stratus is also, as indicated under *Cirrus*, the modification which most frequently and completely exhibits the phenomena of the solar and lunar halo, and also the parhelion and paraselene. Hence the reason of the prognostic of foul weather commonly drawn from the appearance of halo.

The compound modifications are :—

Cumulo-stratus. The cirro-stratus blended with the cumulus, and either appearing intermixed with the heaps of the latter, or superadding a wide-spread structure to its base. "This," remarks Sir J. Herschel, "would seem to be the modification of *cumulus*, when the columns of rising vapour which go to form it arrive in an upper atmosphere not sufficiently dry to round off its summits by rapid evaporation, allowing them to spread horizontally and form flat-topped, mushroom-shaped masses; the upper parts of which are often curled by the wind of an upper current into cirrous wisps, or cleanly cut off by a horizontal plane, forming an 'anvil-shaped cloud,' with a lateral projection, generally considered as a precursor of wind below. Its tendency is to spread, overcast the sky, and settle down into the *nimbus*," which finally falls in rain.

"When," according to Mr. Howard, "a whole sky is crowded with this modification, the appearances are indistinct. The cumulus rises through the interstices of the superior clouds; and the whole, seen as it passes off in the distant horizon, presents to the fancy mountains covered with snow, intersected with darker ridges, lakes of water, rocks, and towers, &c. The *distinct* cumulo-stratus is formed in the interval between the first appearance of the fleecy cumulus and the commencement of rain, while the lower atmosphere is yet dry; also during the approach of thunder-storms; the *indistinct* appearance of it is chiefly in the longer or shorter intervals of showers of rain, snow, or hail."

Nimbus, or Cumulo-cirro-stratus. The rain-cloud. A cloud, or system of clouds, from which rain is falling. It is a horizontal sheet, above which the cirrus spreads, while the cumulus enters it laterally and from beneath. It is the lowest of clouds next to the stratus. Clouds in any one of the preceding modifications, at the same degree of elevation, or in two or more of them at different elevations, may increase so as completely to obscure the sky; and may at times put on an appearance of density, which to the inexperienced observer indicates the speedy commencement of rain. "It is nevertheless extremely probable," Mr. Howard states, "as well from attentive observation as from a consideration of the several modes of their production, that clouds, while in any of these states, do not at any time let fall rain. Before this effect takes place, they have been uniformly found to undergo a change attended with appearances sufficiently remarkable to constitute a distinct modification. These appearances, when the rain happens overhead, are but imperfectly seen. We can then only observe, before the arrival of the denser and lower clouds, or through their interstices, that there exists *at a greater altitude* a thin light veil, or at least a hazy turbidness. When this has considerably increased, we see the lower clouds spread themselves till they unite in all points and form one uniform sheet. The rain then commences; and the lower clouds, arriving from the windward, move under this sheet, and are successively lost in it. When the latter cease to arrive, or when the sheet breaks (letting through the sunbeams), every one's experience teaches him to expect an abatement or *cessation* of *the rain*. But there often follows, what seems hitherto to have been unnoticed, an immediate and great addition to the quantity of *cloud*. At the same time the actual obscurity is lessened, because the arrangement which now returns, gives freer passage to the rays of light; for on the cessation of rain, the lower broken clouds which remain rise into cumuli, and the superior sheet puts on the various forms of the cirro-stratus, sometimes passing to the cirro-cumulus. . . . . The nimbus, although in itself one of the least beautiful clouds, is yet now and then superbly decorated with its attendant the rainbow: which is seen in perfection when backed by the widely extended uniform gloom of this modification."

Further particulars of all the modifications of cloud, and their connection with the weather, and with other atmospheric phenomena, will be found in Mr. Howard's work. In the 'Meteorological Observations'

made at the Royal Observatory, and annually published in the 'Greenwich Observations,'—as stated in the 'Introduction,'—"the clouds and weather are described generally by Howard's Nomenclature;" the following notation being used for the former: ci. *cirrus*, ci-cu. *cirro-cumulus*, ci-s. *cirro-stratus*, cu. *cumulus*, cu-s. *cumulo-stratus*, n. *nimbus*, s. *stratus*. The only adjectives, we may add, which have been formed from these names are "cirrose" and "cirrous," identical in signification, of which the latter is generally employed.

Rear-Admiral Robert Fitz Roy, F.R.S., now Superintendent of the Meteorological Department of the Board of Trade, in London, in his Appendix (published in 1839) to vol. ii. of the 'Narrative of the Surveying Voyages of H.M.S. Adventure and Beagle,' the latter of which he commanded, and in which, besides examining the southern shores of South America, he circumnavigated the globe, has given, pp. 275-6, and illustrated in four plates, a modified classification and nomenclature of the Clouds, in which he has in one direction contracted those of Mr. Howard, and in another greatly extended them. Substituting the term "class" for "modification," he divides clouds into four classes, "cirrus, stratus, nimbus, cumulus;" thus regarding the nimbus, which Mr. Howard considers to be compounded of the other three, as of equal rank in the classification with each of them—as it were as a simple modification. Adopting Mr. Howard's terms for the intermediate and compound modifications (but, with a want of precision often observable in those meteorologists who have in a general manner followed him, ascribing to the former the character of being mixtures of simple modifications, which is true only of the latter), Admiral Fitzroy adds, "Which terms may be rendered more explanatory of the precise kind of cloud by using the augmentative termination *onus*, or the diminutive, *itus*. Thus: cirronus, cirritus; cirrono-stratus, cirrito-stratus; cirrono-cumulus, cirrito-cumulus; stratonus, stratitus; cumulonus, cumulitus; cumulono-stratus, cumulito-stratus. Should these be found insufficient," he continues, "to convey distinct ideas of every variety of clouds, the second word may be augmented or diminished thus: cirrono-stratitus," &c. He also partially adopts an English nomenclature for his classes of cloud, which had first been proposed some years after the publication of Mr. Howard's paper; thus: curl-cloud, flat-cloud, rain-cloud, heap-cloud. But, as Mr. Howard had remarked ('Clim. of Lond.' first edit. vol. i. p. xxxii.) the English words employed do not fully denote the ideas expressed by the Latin terms he had given, which have the further advantage of being adapted for use in all countries. And accordingly, although half a century has elapsed since the first suggestion of the English terms, and twenty years since its revival by Admiral Fitz Roy, meteorologists and other observers have continued to employ Mr. Howard's original designations.

It may be doubted, also, whether the extended nomenclature in Latin proposed by Admiral Fitz Roy, would not, if adopted, become rather an incumbrance than a benefit. Frequent observation of the clouds for a considerable period,—and for several years under the personal correction of the author of the original nomenclature himself,—appears to the present writer to justify him in the opinion, that if the additional denominations are to be regarded as expressing only the increased or diminished magnitude of the several modifications as witnessed, they are unnecessary, it being better to use ordinary descriptive language for the purpose; and that, if they be regarded as describing minute variations in the aspect of the clouds, they involve an attempt minutely to define that which is too irregular and uncertain to be made the subject of formal science. The examination of the figures given in the plates confirms this opinion; but it may be admitted on the other hand, that Admiral Fitz Roy has observed the clouds over a greater area of the globe, in longitude and latitude, than most other meteorologists who have attended to them, and that an objection similar to the last has been made at various periods to Mr. Howard's classification itself. The sufficiency of this, however, appears to have been established by the judgment of meteorologists in general, the only one who has even partially adopted the extension of it, as far as we are aware, being Professor C. Piazzi Smyth, and he, in his two works on the Teneriffe Astronomical Experiment, has merely added the augmented term *cumuloni* to Mr. Howard's original designations; while he is known to have recorded his experience of their equal applicability, also, in climes so different and so distant from Teneriffe, as well as from each other, as South Africa and Great Britain.

Sir J. F. W. Herschel, whose observations of the heavenly bodies have led him to give constant attention to the processes going on in the medium through which they are necessarily viewed, has recorded in his memoirs of special astronomical or other observations, and philosophically considered in his more general treatises, many of the more important phenomena of the clouds, which he has treated in a very original manner, evolving, we believe, some comprehensive truths, for which we are either entirely or principally indebted to him. Thus he shows, in the article 'Meteorology,' in the eighth edition of the 'Encyclopædia Britannica' (from which also are derived the additional characters of certain modifications already given), that when a body of vapour is generated from any warm evaporating surface, it ascends by its relative levity, losing sensible heat, as well by its own expansion as by its bodily transfer into and intermixture with colder air. Should the supply of vapour, however, not be very copious, and should it find itself in its ascent always in a region hygrometrically dry, it by no means follows that it will reach the point of precipitation; but should

the reverse of these conditions obtain, namely, a copious and continual supply from below, and a state of vaporous tension already existing aloft approaching saturation, a portion will be precipitated in visible cloud, on ariving at a certain level. When this process takes place in a calm state of the air, and the evaporating surface is limited in extent, or irregularly distributed in patches (as over marshy ground, rivers, lakes, &c.), or if any other cause dispose the vapour to rise in columnar bodies of greater or less extent, the summits of these are marked by protuberant masses, or piles of cloud, with generally rounded outlines, which appear to repose on flat bases, indicating the "vapour plane," [VAPOUR-PLANE] or that level where hygrometric saturation commences. These are cumuli. So produced, "they abound," Sir J. Herschel observes, "in the calm latitudes of the equatorial seas, and form a distinguishing feature in the meteorology of that region."

"That the mere self-expansion of the ascending air," he continues, "is sufficient to cause precipitation of some of its vapour, when abundant, is rendered matter of ocular demonstration in that very striking phenomenon so common at the Cape of Good Hope, where the south or south-westerly wind which sweeps over the Southern Ocean, impinging on the long range of rocks which terminates in the Table Mountain, is thrown up by them, makes a clear sweep over the flat table-land which forms the summit of that mountain (about 3850 feet high), and thence plunges down with the violence of a cataract, clinging close to the mural precipices that form a kind of background to Cape Town, which it fills with dust and uproar. A perfectly cloudless sky meanwhile prevails over the town, the sea, and the level country; but the mountain is covered with a dense white cloud, reaching to no great height above its summit, and quite level, which, though evidently swept along by the wind, and hurried furiously over the edge of the precipice, dissolves and completely disappears on a definite level, suggesting the idea (whence it derives its name) of a 'Table-cloth.' Occasionally, when the wind is very violent, a ripple is formed in the aërial current, which, by a sort of rebound in the hollow of the amphitheatre in which Cape Town stands, is again thrown up, just over the edge of the sea, vertically over the jetty, where we have stood for hours watching a small white patch of cloud in the zenith, a few acres in extent, in violent internal agitation (from the hurricane of wind blowing through it), yet immovable, as if fixed by some spell, the material ever changing, the form and aspect unvarying."

Of the suspension of the clouds in the air, a subject apparently very simple, but which really involves a variety of physical principles, the most recent view is that of Sir J. Herschel also, stated in the following terms, in the article already cited:—

"When the sun shines on a cloud which absorbs its heat, the cloud itself is necessarily partially evaporated, and the vapour, by its levity, tends to produce an upward current, and thus to counteract the effect of gravity on the globules of which it consists. A globule of water $\frac{1}{4000}$ in. in diameter, in air of five-sixths of the density on the surface, or at the height of about 5000 feet, would have its gravity counteracted by resistance, with a velocity of descent of one foot per second (supposing no friction and no drag); and even if the terminal velocity were reduced to half that quantity by these causes, would still require some such upward action to enable it to maintain its level—a circumstance which sufficiently accounts for the lower level generally observed of cloud during the night. It is more than probable, however, that when not actually raining, cloud is always in process of generation from below and dissolution from above, and that the moment this process ceases, rain in the form of 'mizzle' commences. In a word, a cloud, in general, would seem to be merely the visible form of an aërial space in which certain processes are at the moment *in equilibrio*, and all the particles in a state of upward movement."

Just pausing to call attention to the important inference with respect to the abstract nature of a cloud, first drawn, we believe, by the accomplished philosopher we are quoting, and contained in the last period of this extract,—we may observe that, to complete the view he takes of the causes of the suspension of the clouds, nothing seems to be required but an adequate estimate of the effects of the 'friction' and the 'drag,' which are supposed not to exist. But it appears to have escaped the attention of Sir J. Herschel, that Professor G. G. Stokes had already shown that the internal friction of the air, together, of course, by implication, with the drag which it occasions, is itself one of the causes—in his opinion, indeed, the main cause—of the suspension of the clouds. As this particular subject is new, and of great importance in meteorology, we shall treat it at some comparative length.

Clouds consist of an aggregation of separate minute globules of water; and the resistance of such a globule falling through the air with its terminal velocity depends almost wholly on the cause just stated. "Since the index of friction of air is known from pendulum experiments, we may," Professor Stokes observes, "easily calculate the terminal velocity of a globule of given size, neglecting the part of the resistance which depends upon the square of the velocity. The terminal velocity thus obtained is so small in the case of small globules, such as those of which we may conceive a cloud to be composed, that the apparent suspension of the clouds does not seem to present any difficulty. . . . . Since in the case of minute globules falling with their terminal velocity the part of the resistance depending upon the square of the velocity is quite insignificant (as will presently be shown) compared with the part which depends on the external friction of the air, it follows that were the pressure equal in all directions in air in the state of motion (which according to the common theory of the fundamental assumption in hydrodynamics, it would be), the quantity of water which would remain suspended in the state of cloud would be enormously diminished.

To render this view of the subject complete, and to explain the value of the last observation, it must here be stated that Professor Stokes had before shown that the fundamental assumption of hydrostatics and hydrodynamics, that the pressure of a fluid is equal in all directions, though fully justified by experiment in the case of a fluid at rest, is not true in the case of a fluid in motion. The viscosity attributed to water by Dubuat, and the inherent property, "analogous to that of viscidity in liquids," ascribed to elastic fluids by Captain (now Major-General) Sabine, from their respective pendulum experiments, were generalised by Professor Stokes as consequences of the internal friction of fluids in general, all fluids exerting a resistance to bodies passing through them, independently of their density; and when this is taken into account, it is evident that the pressure cannot be equal in all directions.

The suspension of the globules of water forming the clouds is only a particular case of the more general fact, that fine powders remain nearly suspended in a fluid of widely different specific gravity. Professor Stokes has demonstrated that the resistance of the fluid, whether liquid or gaseous, is proportional, not to the surface, but to the radius of the spherule, and consequently the quotient of the resistance divided by the mass,—in other words, the accelerating force of the resistance,—increases much more rapidly as the radius diminishes, than if the resistance varied as the surface: on which principle the suspension, or proximate suspension, of the particles or globules depends. When the downward motion of a globule is so slow that the part of the resistance which depends on the square of the velocity may be neglected, the terminal velocity of a globule of water forming part of a cloud may be determined. For a globule the one-thousandth of an inch in diameter, we have the velocity 1·593 inch per second. For a globule the one ten-thousandth of an inch in diameter, the terminal velocity would be a hundred times smaller, so as not to amount to the one sixtieth part of an inch per second.

The amount of that part of the resistance which varies as the square of the velocity, is the only kind of resistance that could exist if the pressure were equal in all directions, for the velocity 1·593 inch per second is not quite the one four-hundredth part of the weight; and for a sphere only the one ten-thousandth of an inch in diameter, the ratio of the resistance to the weight would be ten times as small. Both these proportions, it is manifest, are quite insignificant.

The conclusion thus arrived at by Professor Stokes as to the cause of the suspension of the clouds, illustrates in a remarkable manner the connection of different branches of science. It is an application by him of the theory of internal friction, as applied to the ball pendulum, and verified by recorded experiments on that instrument, and is contained in his memoir 'On the Effect of the Internal Friction of Fluids on the Motion of Pendulums,' published in the 'Transactions of the Cambridge Philosophical Society,' vol. ix. The erroneous extension of the fundamental law of hydrostatics had been discussed by him in a paper 'On some Cases of Fluid Motion,' inserted in the preceding volume of that work.

The height of the clouds in the atmosphere at any particular locality necessarily varies, like their production itself, with the quantity of vapour in the air, the climate, the season, the temperature at the time of observation, the local decrement of temperature for ascent, the elevation of the superimposed currents of air, the extent of the land, the proximity of the sea, the existence and altitude of mountains, and a variety of other circumstances relating both to the earth and the atmosphere. It would appear that the altitude of the highest mountains gives the upper limit of the region of the clouds, which is thus seen to comprise those denser strata of the atmosphere resting immediately on the earth's surface, which include considerably more than two-thirds of the ponderable body of air incumbent on the globe, the highest mountains known not exceeding five miles and a-half in height; while the principal mass of the clouds probably belongs to a region of which the superior limit is about a mile below this. Mr. Dalton correctly asserted, that in England the height of small fleecy patches of cloud, meaning *cirri*, was frequently from three to five miles. The following observations, relating to the elevation of the clouds in the interesting district of the English lake mountains, are given by Mr. Dalton in the first edition of his 'Meteorological Essays' (1793), the observer being Mr. Crosthwaite of Keswick. By accurate measurement of Skiddaw, and fixing marks on the side of the mountain, which is 1050 yards high [correctly 1007 yards], he was able to ascertain by inspection the height of any cloud, when it did not exceed that of the mountain.

This he did three times each day, morning, noon, and evening, for five years, missing only as many observations as amounted to omitting less than a week per year. The result is as follows, the last column but one giving the number of times in which either the clouds were above the mountain, or there were no clouds at all, the last circumstance occurring about once out of thirty times.

Month.	0— 100 yards.	100— 200 "	200— 300 "	300— 400 "	400— 500 "	500— 600 "	600— 700 "	700— 800 "	800— 900 "	900—1000 "	1000—1050 "	Above 1050 "	Number of Obs.
Jan. .	0	9	12	28	53	39	37	32	30	39	36	116	431
Feb. .	5	10	5	15	41	45	45	27	43	38	29	94	397
Mar. .	2	1	6	11	22	40	32	36	24	32	44	184	434
April.	0	4	5	18	24	34	37	26	23	38	35	206	450
May .	0	1	4	8	13	31	22	25	30	34	27	270	465
June .	0	2	2	6	24	24	29	21	34	41	34	233	450
July .	0	2	2	18	35	36	35	25	35	48	38	191	465
Aug. .	0	4	5	13	27	39	35	26	25	45	30	215	464
Sep. .	0	1	7	13	38	38	32	30	27	51	27	186	450
Oct. .	2	0	5	13	26	49	31	31	46	61	37	164	465
Nov. .	0	0	3	13	30	58	42	38	46	45	47	128	450
Dec. .	1	8	6	23	41	53	39	50	47	46	35	111	460
Total.	10	42	62	179	374	486	416	367	410	518	419	2098	5381

Thus, it appears that in the month of September, for instance, for seven times that the clouds were between 200 and 300 yards high, there were 38 times in which they were between 500 and 600 yards high, &c. The supposition of the height of the clouds depending on the barometer, was in no degree countenanced, and though in heavy and continued rains the clouds were mostly below the summit, yet it frequently rained when they were above it. These observations, however, are chiefly valuable in relation to the local phenomena. (See J. F. Miller on the Meteorology of the Lake District, in 'Phil. Trans.,' 1848, p. 87.) Of much greater importance are those of the late Mr. John Welsh, F.R.S., in four balloon ascents, made in 1852, under the direction of the Kew Observatory committee of the British Association for the Advancement of Science, and published in 'Phil. Trans.,' 1853. The ascents were all made from Vauxhall Gardens, on the south bank of the river Thames, in the south-west district of London.

At the first ascent, on August 17th, 1852, clouds covered about three-fourths of the sky, the lowest stratum being a few detached masses of loose cumulus; a dense mass of cirro-stratus (or stratus) being above, with perhaps occasional patches of cumulus intermediate. The altitude of the lowest clouds, which extended only over a small area, was estimated during the ascent at about 2500 feet, or 500 feet less than that of Skiddaw. Between this and about 13,000 feet, the air seemed free of clouds; after this, there seemed to be occasional masses of loose cumulus at no great distance. When at the greatest elevation, 19,510 feet, or about three miles and three-quarters, there was, at apparently a short distance above the balloon, a thick mass of cloud, probably the cirro-stratus which had been seen from the earth. At this elevation the temperature was 9·5°, or 22·5° below freezing; and at about this time, though while still rising, a few small star-shaped crystals of snow fell, a fact coincident with what has been remarked in a former part of this article, of the probably frozen condition of cirrus. At the second ascent, on the 26th of August, the sky was to a small extent obscured by detached masses of cumulus, but the sun shone brightly throughout the ascent. The only clouds passed were at the estimated height of 3000 feet; above this no clouds were met with, while the ascent was made to 19,100 feet, the sky being exceedingly clear, and of a very deep blue colour. The third ascent was made on October 21st, on the morning of which a fog which had existed on the previous night slowly disappeared, leaving the air in a very calm state and with some haze. A dense mass of cloud, probably stratus, covered the sky; one or two slight showers falling about 10 A.M. Between the heights of 1000 and 2800 feet various detached and irregular masses of loose "scud" were encountered, but the balloon had not completely entered the dense mass of cloud till the height of nearly 3000 feet. At a height of 3700 feet the upper surface of the cloud was reached, and the sun was seen shining through thin cirrous clouds at a great height. The height of the upper surface of the cloud was again observed during the descent to be 3450 feet. When the balloon was close to the clouds, it was remarked that the general level of the surface was very uniform, presenting however a hillocky appearance; the irregularities being small, apparently not exceeding a very few feet. Shortly after clearing the clouds, a shadow of the balloon was seen on the surface, fringed with a glory; with this shadow as a centre, there was also observed a circle of whitish light, the outer edge of it slightly tinged with yellow; its diameter being estimated at 80°. About this time there was noticed, stretching for a considerable length in a serpentine course over the surface of the cloud, a well-defined belt, having the appearance of a broad road, both sides being strikingly distinct. The thin cirrous clouds already mentioned seem not to have been passed, the descent being made from the elevation of 12,640 feet, at which the temperature was 26·7°.

The reader will not fail to connect the thin cirrous clouds seen at a great height, through which the sun was shining, with the glory and the circle of light surrounding the shadow, and remark in reference to the frozen state of such clouds both the fact that they were above 12,000 feet, and the temperature observed. Perhaps the serpentine belt may have been the horizontal summit or upper plane of a comparatively narrow current of air with vertical sides, which had deposited its own mass of cloud, in the form of a waved wall.

The fourth and last ascent took place on the 10th of November, when the surface wind and the lower current of "scud" were moving very slowly; the upper clouds were only occasionally visible. At a height of 500 feet the first cloud, thin scud, was entered, the *upper* surface being 1970 feet high. A space of 2000 feet was clear of clouds, and at 4000 feet the second stratum of clouds was reached, its upper surface being found to be 4900 feet high. After this no clouds were met with, the sun shining through thin cirrous clouds, which must have been at a very great height. The greatest elevation attained was 22,930 feet, and the lowest temperature observed, at 560 feet lower, was 10·5° below zero. So that the height of the *cirrus* was above 23,000 feet, or about four miles and three-eighths, at which it must necessarily have been frozen, to have a visible existence in clear sunshine; and the same inference may in fact be drawn with respect to some of the preceding instances at much lower altitudes.

The nautical term *scud*, denoting, apparently, broken fragments of cloud, is frequently employed by meteorologists at the present time, as by Mr. Welsh above, and in the Greenwich observations; but we must confess our ignorance to what modification and in what state it is intended to apply, or whether it is regarded as equivalent to an additional modification: an ignorance in which we know Mr. Howard to participate. Its undefined use seems to indicate insufficient attention to the *structure* of the clouds.

Of the elevation and distribution of the clouds at Teneriffe, we have some definite information in Professor C. Piazzi Smyth's report (already cited) of the astronomical experiment of 1856 made on the Peak (or in 'Phil. Trans.,' 1858), pp. 481, 527. Observed both from the upper station of Alta Vista at the height of 10,702 feet above the sea, and the lower one of Guajara at that of 8,903 feet—though fog and mountain-cloud existed below and appeared daily, dense, closely packed together, and rolling upon each other—they showed no tendency to rise higher than 4500 feet, or rather more than seven-eighths of a mile. With this depression of the mountain-cloud, including cumulus, cumulo-stratus, and nimbus, below him, Professor Smyth had, he found, but the thinner forms of cloud, cirrus, cirro-cumulus, and some cirro-stratus, ever at any time floating above him, or interfering with the view of the heavens; and these only appeared about once in five days in any considerable quantity. The lowest strata of cloud, he observed, were 2300 feet, or less than half a mile, above the sea; of the elevation of the upper clouds he had no means of accurately judging, but he suspected that it could not have been less than 15,000 feet, or nearly three miles. Sometimes there was cloud on the summit of the Peak, which gives a height of 12,000 feet, about two miles and a-quarter. Professor Smyth also observed that the stratum of the mountain-cloud of Teneriffe did not occur in the space between the two winds which were found blowing at the top and bottom of the mountain, respectively, the S.W. wind above and the N.E. trade-wind below [CALM], but in or below the middle of the N.E. current of air, which extends in height from the very sea itself to about 9000 feet. The mountain-cloud is limited in horizontal extent to a few miles, but even the sea-cloud, the true N.E. cloud, which was far more extensive, stretching as far as the eye could observe, when viewed from many thousand feet above, and extending, in fact, several hundred miles from the island, only reached to between 4000 and 5000 feet of elevation, or to half the height or depth of the N.E. wind, in the midst of which, like the mountain-cloud, it was thus included. It seems probable, therefore, that in all climates, the rainless tracts excepted, a considerable stratum of cloud commonly exists over the land, the inferior surface of which is at a height varying from somewhat less to rather more than half a mile, or from 2500 to 3000 feet, whatever of cloud there may or may not exist above or below that altitude. [CLIMATE; DEW; EVAPORATION; HAIL; HALO; HYGROMETRY; LIGHTNING; METEOROLOGY; RAIN; SNOW; SKY; VAPOUR.]

CLOVER, a name given to different species of Trifolium. Dutch clover is *T. repens;* purple clover is *T. pratense;* cow-grass, or perennial clover is *T. pratense perenne;* Alsike clover is *T. hybridum; T. medium* is also called cow-grass; scarlet clover *T. incarnatum;* hop trefoil is *T. procumbens.*

Clover was introduced into the agriculture of Great Britain about the 16th century, from the Low Countries, where it had been long cultivated as green food for cattle in situations where natural pastures were scarce. It was the first step towards the improvement of the old triennial system. Its abundant produce, its destruction of annual weeds, which it smothers by its broad foliage, and especially the beauty of the wheat sown after it, soon recommended it as an indispensable part of an improved rotation of crops. It is not too much to say, that under certain kinds of management, the profit of any farm may be considered as proportionate to the quantity of clover which is produced upon it on an average of years. There are various kinds of clover, which all go under the botanical name of *trifolium*, from the three leaves which grow together, or rather the form of the leaf, which has three heart-shaped parts. They are annual, biennial, or perennial plants. The annual clovers, with the exception of the trifolium incarnatum (*Trèfle incarnat* or *farouche*), introduced from the south of

France, are not so generally cultivated as the biennial, which produces a greater crop, and being sown along with the spring corn comes up the first year under its shade, and gives a full crop in the second. In good land it will sometimes stand another year, but it falls off in quantity; and unless other artificial grasses or perennial clovers have been sown amongst it, to fill up the places where the biennial clover has failed, it is seldom profitable to allow it to remain on the ground more than one year after that in which it is sown.

The most approved variety of the biennial clovers is the common red or broad clover (*Trifolium pratense*), which is usually sown with barley or oats, or sometimes among wheat or rye in spring. When these are drilled and hoed there is an advantage in sowing the clover seed among a crop which is already advanced in growth, because it is kept under, and there is no danger of its injuring the chief crop by its too great luxuriance. There is however some risk of the clover not coming up so well, if the wheat or rye is very close on the ground. In Scotland clover is often sown among wheat, in Norfolk invariably with barley, and in Belgium among rye. This depends on the various rotations adopted in different countries. The first crop is generally mown and made into hay. In this process great care is taken not to break off the tender leaves of the plant in drying; the swathe is not shaken out as is done with meadow grass, but merely turned over; and if the clover can be dried and put in a stack without any shaking, it is so much the more valuable. When clover is soaked with rain, no hope of an improvement in the stack must induce the farmer to carry it together, so long as the least moisture remains. If it is allowed to stay in the field till it is perfectly dry, even when it has been soaked repeatedly and is nearly black, and is then trod hard in a rick with a sprinkling of salt over each layer, it will be readily eaten by cattle in winter, and be far more nutritious than that which, having been stacked in a moist state, will infallibly come out musty. A very good method in those seasons when a continuance of dry weather cannot be reckoned upon—particularly when the second crop is cut in September—is to take advantage of two or three dry days to cut the clover, and turn it as soon as the dew is completely dried off the upper side; the next day do the same, and in the evening carry the green dry clover and lay it in alternate layers with sweet straw, so as to form a moderately sized stack. A fermentation will soon arise, but the dry straw will prevent all danger from too much heating, and, acquiring the flavour of the clover, will be eaten with avidity by the cattle. To those who make clover-hay for the use of their own stock in winter, we recommend this as preferable to the common method, even when there is less danger from the weather. In northern climates it would probably save the crop two years out of three.

It is usual to sow rye-grass (*Lolium perenne*) in a small proportion with clover seed, especially where clover, having been often repeated on the same land, is apt to fail. It is a good practice; and although in the neighbourhood of London the unmixed clover obtains a better price, there is no reason why it should be preferred, unless the rye-grass has been allowed to stand too long and has grown hard. Young rye-grass is a good corrective of the heating qualities of clover-hay. A very extensive use of clover-hay in London is to cut it into chaff, and to mix with oats and beans for dray horses, which have little or no hay given them in any other way; but the most profitable use of clover is to cut it green for horses and cattle. With a little management and the assistance of tares, green food may be given to all the stock from the first day of May to the end of November.

The land which has borne clover, although in a very good state for producing corn, will not bear a repetition of that crop until several other crops have intervened. In the regular Norfolk rotation, clover should recur every fourth year; but after a few rotations this is found to be too quick a recurrence, and other grass seeds or pulse are substituted.

The white or Dutch clover (*Trifolium repens*) is a perennial, which grows rapidly, and forms excellent pasture; but its bulk is not sufficient to make it profitable to mow it for hay. It is excellent for sheep, which thrive well upon it. A light calcareous soil is best adapted for white clover; but it also grows well on heavy land, provided the bottom be sound and dry. When land is laid down for permanent pasture, white clover is always sown in considerable proportion with other grasses.

Another perennial clover, called cow grass (*Trifolium medium*), is found in all rich meadows. It is often sown in conjunction with the white clover, in laying down arable land to grass. The lesser yellow trefoil (*Trifolium minus*), and the hop trefoil (*Trifolium procumbens*), are also valuable varieties found in good pastures.

The only annual clover which is cultivated is the French clover (*Trifolium incarnatum*), mentioned before. It is a most valuable addition to the plants usually sown for fodder, from the short time in which it arrives at perfection, if sown in spring; so that where clover has failed, this may be sown to fill up the bare places. Its principal use is to raise very early food for ewes and lambs, which it does with very little trouble or expense. Immediately after harvest, the stubble is scarified and harrowed so as to raise a mould; the Trifolium is sown at the rate of 16 to 20 lbs. per acre, and well rolled in. It springs up and stands the winter well, and with the first genial weather in spring it grows rapidly. It makes a coarse but tolerable hay, and what is left produces seed most abundantly in the beginning of June, being off the ground in good time to plough the land and clean it for turnips. It is far superior to stubble turnips as an intervening crop, and more rapid in its growth than tares. On light land a crop of turnips is readily obtained after it. It has the property of smothering annual weeds by its rapid growth, and for this reason is not so well adapted for sowing with a crop of corn. The Italian rye-grass (*Lolium perenne Italicum*) may be sown with it, and will grow as rapidly. After the Trifolium has been cut, this will continue and give an excellent second crop. It is advisable to have fresh seeds from southern climates from time to time, or it will probably become later every year by assimilation to the climate. English seed of the first year after importation seems the best, being heavier and more free from weeds than the foreign.

Some agriculturists have objected to the practice of sowing clover with a crop of corn; they prefer hoeing the intervals between the rows of the drilled crops, by which the weeds are better kept down. They plough the land immediately after harvest, and, harrowing it well, they sow clover and grass seeds, which come in nearly as soon the next year as if they had been sown in the preceding spring; and the land, when broken up, is in a much cleaner state than if the clover had been sown with the corn. If this be not an improvement in the system, it is at least worthy of notice, and experience alone can decide whether the additional expense of ploughing is repaid by the improvement in the crop.

In France, and in the United States of North America, gypsum is considered as a specific manure for clover. It is sown by hand over the plant in spring; and in some situations the advantage is evident, in others scarcely observable. The quantity used is from three to eight bushels of finely powdered gypsum per acre.

On good land, an acre of clover will produce as much as three tons and a half of dry hay; that is, two tons the first cutting, and one and a half the second. Greater crops are obtained on very highly manured land. The value of a ton of clover-hay to feed horses with is about 15 or 20 per cent. more than good meadow-hay. It is not however so for good milch cows.

When clover is intended to be left to ripen its seeds, it should be mown early, or fed off by sheep in May. The first crop is seldom free from various seeds of other plants which rise among the clover; by feeding it down or mowing it these are destroyed, and the clover, which grows more rapidly than most other plants, rises again without any mixture of weeds. When the blossom is thoroughly withered, and the seed is nearly ripe, the clover is mown and left to dry on the ground without much shaking. In very dry weather it may be housed or stacked in a week; but the process is much retarded by showers and want of sunshine. It is, therefore, only in the drier parts of the island that clover-seed repays the expense and risk of cultivation, especially as it is well known that the subsequent crop suffers if the clover is allowed to stand for seed. It is seldom, therefore, that more seed is saved, even in the most favourable situations and seasons, than is required for the farm or immediate neighbourhood. The demand from the north, where clover is sown to a great extent, could not be supplied without a considerable importation from abroad; and the importation of clover-seed from Belgium and Holland is very considerable, as it is more advantageous to purchase foreign seed than to raise it, except in the case of the *Trifolium incarnatum*, which produces early and abundant seed. Foreign clover-seed should be well examined when it is purchased, as it frequently contains the seeds of docks and other noxious weeds. The usual mode of doing this is very simple. The thumb is moistened and pressed on the sample, some of the seeds adhere, and when it is turned up the quality is distinctly seen by the colour and plumpness of the seeds. If any seeds of weeds are in it, they must be detected after a few insertions of the thumb. As the calyx of the flower of clover envelopes the seed closely, it is difficult to separate them. Threshing-machines for this purpose are in use; but if the heads, after being separated from the haulm, are put together in a heap and pressed, a slight fermentation takes place, and this makes the calyx brittle, so that it breaks into dust, and the seed comes out readily; it is then easily cleared by the fan.

When the seed is not intended for the market, the trouble of clearing it of the husk may be saved, especially in the *Trifolium incarnatum*. It will grow as well when sown with the husk as when cleaned; and it is easy to find the proportion required to be sown in that state by allowing for the weight of the husk.

CLOVES. [CARYOPHYLLUS.]

CLUB is defined by Johnson to be "an assembly of good fellows, meeting under certain conditions;" but by Todd, "an association of persons subjected to particular rules." It is plain that the latter definition is at least not that of a club as distinguished from any other kind of association, although it may not be more comprehensive than is necessary to take in all the associations that in modern times have assumed the name of clubs. Johnson's, however, is the more exact account of the true old English club.

It might not be quite safe to make a positive assertion as to the antiquity either of the name or the thing in England. But the earliest clubs remembered in our popular literature date about the end of the 16th or the beginning of the 17th century. It was then that there was established the famous club at the Mermaid Tavern, in Friday Street, of which Shakespere, Beaumont, Fletcher, Raleigh, Selden, Donne, &c., were members.

Ben Jonson had another club, of which he appears to have been

the founder, that met at another well-known tavern, called the Devil Tavern. It stood between the Temple Gates and Temple Bar. It was for this club that Jonson wrote the 'Leges Convivales,' which are printed among his works.

It seems to have been not till a considerable time after this that political clubs first came into vogue.

In the 'Spectator,' No. 78, Addison makes mention of "the club, or rather the confederacy, of Kings. This grand alliance," he observes, "was formed a little after the return of King Charles II., and admitted into it men of all qualities and professions, provided they agreed in this surname of King, which, as they imagined, sufficiently declared the owners of it to be altogether untainted with republican and antimonarchical principles." A famous political club of those days was the King's Head Club, which is alluded to in Tate's continuation of Dryden's 'Absalom and Ahithophel.' It was a whig club; and the badge of its members was a green ribbon, in opposition to the tories, who wore a scarlet ribbon in their hats. (See Dryden's Works, by Scott, vol. vii. p. 154, and vol. ix. p. 380.)

The great age of clubs, political, literary, and of every other description, was the early part of the last century. Then flourished, among many others, the Brothers' Club, in which were associated Harley, Bolingbroke, Swift, and the other most distinguished literary and political characters of the day: the famous Scriblerus Club, of which Pope, Swift, and Arbuthnot were the leading members: the October Club, of the original institution and subsequent history of which an account may be found in Swift's 'Four last Years of the Reign of Queen Anne,' and also in a satirical pamphlet entitled 'The Secret History of the October Club, from its original to this time, by a Member,' 8vo, London, 1711: the Hanoverian Club: the first Beef-Steak Club, of which Mrs. Woffington, the actress, was president, being the only female member, and Richard Estcourt, the comedian, provisor, wearing in that character a small gridiron of gold, hung round his neck with a green silk ribbon; and, above all, the celebrated Kit-Cat Club, which is said indeed to have been instituted at the time of the trial of the seven bishops, in the reign of James II., but was in its greatest glory in that of Queen Anne; and a most interesting memorial of which, when at its most flourishing period, exists in the famous series of portraits of the forty members, painted by Sir Godfrey Kneller for Jacob Tonson, the bookseller. These Kit-cat portraits, as they are called, are now the property of Tonson's representative, Mr. W. R. Baker, of Bayfordbury, Herts.

In 1735 the second Beef-Steak Club, which has embraced among its members the most eminent public characters that have appeared since its institution, originated with Rich, the pantomimist, and the Earl of Peterborough. For an account of the circumstances, see an entertaining work entitled 'The Clubs of London,' 2 vols., 8vo, London, 1828.

Of clubs of more recent institution, the most famous is that called by its founders and members "The Club," but which is commonly known as the Literary Club, established in the year 1764, of which Johnson, Boswell, Burke, Reynolds, Goldsmith, and other well-known names, were in the original list of members. Along with this may be mentioned the Essex Head Club, also founded a few years after by Johnson. It took its name from the tavern at which it met, in Essex Street. One of the most successful literary clubs of modern times was that called the King of Clubs, which began about the year 1801, and used to meet at the Crown and Anchor, in the Strand. An account of it is given in the second volume of the 'Clubs of London.'

The modern subscription houses which go by the name of clubs, such as the Athenæum, the University, the Senior and Junior United Service, and others of the same description, are in no other respect clubs, according to the ancient English understanding of the term, except that every member must be balloted for, or admitted by the consent of the rest. And little more of the true character of a club belongs to those numerous political associations known as the Whig Club of Brookes's, the club at White's, the Carlton Club, &c. Political associations, in imitation of those existing in England, were formed at Paris in the earliest stage of the French revolution, and assumed the English name of clubs. The Breton Club, the Jacobin Club, the Club des Feuillans, and others, performed an important part in the various scenes of that extraordinary drama.

CLUNY, ORDER OF MONKS OF; a branch of the Benedictines. Their original abbey was situated at Cluny in the department of the Saone, and they were distinguished as being reformers of the Benedictine order in 927, most strictly observing the rules as prescribed by its founder. Under the name of Cluniacs they became very popular, and by the 12th century they numbered 2000 cloisters in various parts of Europe. William, Earl of Warren, son-in-law to William the Conqueror, brought these monks into England, and built their first house at Lewes, in Sussex, about A.D. 1077 or 1078; and in the latest edition of Dugdale's 'Monasticon,' forty-two are mentioned, exclusive of three cells whose existence is not very distinctly known.

All the monasteries of this order in England were governed by foreigners, had more French than English monks in them, and were not only subject to the foreign houses of Cluny, La Charité sur Loire, and St. Martin des Champs at Paris, but could be visited by them only. None of their priors were elected by the respective convents, but were named by the above-mentioned foreign houses. They could not receive the profession of their novices in England. To have their differences determined, they were obliged, in almost all cases, to go to their superiors beyond sea; by which means the greatest part of their revenues were carried to those foreign houses: and upon that account, during the wars with France, the different establishments of this order were generally seized into the king's hands as alien priories. After a petition from a large number of the English Cluniac monks to the parliament at Winchester in the 4th Edward III., these inconveniences were by degrees removed; and some of their houses were in that and the following reign made denizen. Bermondsey, one of the greater houses of this order, was made an abbey; and all of them were at last discharged from all manner of subjection and obedience to the foreign abbeys. Tanner says this did not take place till 1457, when a deputation from the parent abbey of Cluny, sent to Henry VI., in addition to claiming the restitution of their possessions generally, desired leave to enter all places depending upon their houses; but instead of obtaining what they asked, they were deprived of the subjection of all houses of their order in England. After a while the Cluniacs were eclipsed by the Cistercians.

Slevesholm, in Norfolk, was the last of their houses founded in England, about 1222. Four of their principal establishments were among those which Cardinal Wolsey dissolved in 1525; and the rest followed at the Reformation.

CLUTCH. [COUPLING.]

CLY'PEUS SOBIESKI (the shield of Sobieski), a constellation formed by Hevelius out of some small stars below Aquila, and passing the meridian about an hour before α Aquilæ. The name was given in honour of John Sobieski III., king of Poland. None of the stars in this constellation exceed the fifth magnitude.

CLYSTERS (the Greek κλυστῆρ), lavements, or enemata, terms bestowed upon medicinal agents introduced into the rectum, or lower bowel, with the intention of expelling its contents, or producing other local effects, but also occasionally to influence the system generally. The intestinal canal, from its commencement at the mouth to its termination in the rectum, is endowed with peculiar sensibilities; and though each portion of it has some special office, yet the whole responds to certain stimulants, whatever part they may be applied to. Thus purgative medicines may be introduced into it either by the mouth or by the rectum, and to a certain extent their action is the same, that is, both will occasion an expulsion of the contents of the lower bowel; but the secondary influence on the system will be different, inasmuch as when the purgative is given by the mouth, during the whole course of its descent it produces, according to its nature, a special action on each portion as it passes, frequently causing an increased secretion of serum, and so materially affecting the general system. But when the same substance is introduced by the rectum, it only produces a local effect, by bringing about the expulsion of the contents, and influencing the system generally only when these were of such a nature as to occasion irritation by their retention. Clysters are also employed to assist in retaining the contents of the bowels when they are expelled too frequently, as in many cases of diarrhœa. Clysters of this latter kind are likewise used to aid in retaining the contents of some of the neighbouring organs, such as of the uterus, in cases where abortion is threatened; and are also employed to allay pain and irritation in the bladder, kidneys, &c. Further, when the mouth or upper part of the throat is closed, as in spasmodic diseases, such as lock-jaw, or from tumours or paralysis, they are frequently made the vehicle for introducing either food or medicine into the system. The only other point requiring notice here is the fact that as the sensibility of the rectum is considerably less than that of the stomach, the doses of most articles given as clysters must be greater than when administered by the mouth.

Clysters are rarely, except in two instances, taken or administered without the order or superintendence of a competent medical attendant, and therefore we shall confine our observations chiefly to those two cases. The first and most common is where persons employ them for the relief of constipation; for this purpose tepid water or gruel is, by means of a proper instrument, thrown up into the rectum, and when a suitable quantity (about a pint) is used, it is generally speedily returned, bringing with it the other contents of the lower bowel. To the occasional use of such means no objection can be urged; but if employed habitually, and as a substitute for the efforts of nature, the greatest injury will result. Constipation does not in general depend upon a want of power in the rectum to expel its contents, but upon the use of improper diet, or a deficiency of the secretions of the upper part of the intestinal canal, such as the bile, which furnishes the natural stimulus to the intestines; and clysters never can effectually supply the want of these secretions. By the abuse of clysters, the tone of the whole alimentary canal may be lost, and the process of nutrition so impaired that wasting and other serious consequences have followed. Clysters even of the mildest kind should therefore be restricted to the accomplishment of temporary and occasional purposes. At the commencement of fevers and other inflammatory complaints, the speedy evacuation of the contents of the rectum is desirable; and where medicines cannot be taken by the mouth, owing to the irritability of the stomach causing their rejection, clysters of purgative substances, such as castor oil, or infusion of senna with sulphate of soda, may be used. For the relief of spasmodic diseases, clysters of the fetid gums, such as

assafœtida, or of oil of turpentine, may be used. Sometimes tobacco in the form of infusion or of smoke is employed; but this requires the greatest care. The second case to which we have alluded, in which clysters are employed without medical superintendence, is that of tobacco-smoke thrown into the rectum of drowned persons: a more hurtful measure cannot be adopted; it is now abandoned by all intelligent persons.

Where clysters are employed to allay pain, or arrest premature action of the uterus, they generally contain tincture of opium, and are of small bulk; about a quarter of a pint of starch serves as the vehicle. Where nourishment is the object, they are also of small bulk; about half a pint of beef-tea alone, or with powdered cinchona bark, and a few drops of laudanum. Substances introduced into the rectum in a solid form are called suppositories.

CNICINE ($C_{40}H_{26}O_{14}$), an active principle found in the sub-order *Cynarocephalæ* of the Composite order of plants. It is neutral and bitter.

COACH. For a variety of information relating to the introduction, commercial importance, and legislative supervision of hackney coaches, mail coaches, stage coaches, cabriolets, Irish cars, and similar means of public conveyance, see STAGE CARRIAGE.

COACH-MAKING. The mechanical details involved in the manufacture of a coach or other vehicle depend, for any peculiarity which they present, rather on the choice and combination of materials than on the actual working processes. There are however a few points which merit attention both as to materials and to processes.

The timber employed in coach-building comprises ash, beech, elm, oak, mahogany, cedar, deal, pine, fustic, larchwood, and birch. Mr. Adams ('Treatise on Pleasure Carriages') gives the reasons for the selection among these species of wood, according to the purpose to which it is to be applied. The timber mostly employed is English-grown *ash*. The "hedge-row" ash, growing in open spots, is of slower growth, but is much firmer, stronger, and tougher than that of the "coppice," and is therefore preferred to it for making the heavy framework of a carriage. Ash is rather a tough and fibrous than an elastic wood, and is well calculated to bear the concussions to which the supporting framework of a coach is exposed; it is best fitted for use when arrived at maturity, but before it has attained its extreme size; it is sometimes white at the heart, sometimes red, the former being best fitted for the purpose in view; it is sometimes so wrinkled in grain as scarcely to be planed smooth, and is then in its toughest state; it acquires by steaming a plastic property, which enables it to be bent to a form suited for carriage-timbers. These various qualities, together with the absence of any tendency to twist or warp, render ash better fitted than any other kind of timber for the skeleton framework of a carriage. *Beech* is a timber used only in building carriages of an inferior kind, since it cannot well bear alternation of air and moisture. *Elm* is used largely for strong planking. Of the two kinds, "hedge-row" elm is more employed than "wych" or "wick" elm. The grain of this wood is curly and wavy, difficult to work, brittle, and apt to split; but when once brought into workable form, elm possesses great strength, especially for the naves of wheels. *Oak* is not employed to any considerable extent in coach-building; but it forms the spokes of wheels [WHEEL], and is used in some cases as a thin planking or "wainscot." *Mahogany* is chiefly in request for forming the panels or broad plain surfaces of the body of a coach. In the use of this kind of wood there is a difference between the cabinet maker and the coach-builder: the former prefers "Spanish" mahogany, on account of the beautiful curled grain which gives such diversity of light and shade; whereas the coach-builder distrusts it, because the curled grain prevents it from being bent into the curvatures required in coach-making. "Honduras" mahogany can be procured in planks four feet in width, perfectly straight-grained, and free from knots and blemishes, and is therefore a kind of timber well fitted for bending. *Cedar*, of considerable width and having a coarse grain, is sometimes used instead of mahogany for coach-panels, when they are to be covered with leather: it is too porous to receive a painted surface. *Deal* is employed for the flooring of carriages, and also for panels which are to be covered. Wide American *Pine*, cut into very thin boards, is used for the roofing. *Fustic*, a hard yellow wood obtained from Central and South America, is sometimes employed for the naves of wheels which are intended for hot climates, as being less liable to shrink than English timber. *Lancewood*, a yellow, close, straight-grained, elastic but brittle wood, was formerly much used for the straight shafts of carriages; but when curved shafts became general, the employment of this wood for the purpose lessened. American *Birch* is much used for flat boarding, on account of its great width, its homogeneous substance, its freedom from rents, the smallness of its pores, its ready yielding to the plane, and the non-appearance of the grain when painted; it is however brittle, and cannot be bent like mahogany for panels. *Sycamore*, *Chestnut*, and *Plane-wood*, are occasionally used as substitutes for some of the above-mentioned woods.

In working up these varieties of timber, tools and processes are employed similar to those witnessed in many other trades. In the first place, a "mould" of the coach body is prepared from the pattern, as in the preparatory stage of ship-building; that is, thin pieces of wood are so cut out as to denote the size, form, and curvatures of all the separate parts of the coach; and these afterwards act as guides in cutting and shaping the timber. The working-operations are of two wholly distinct kinds, carried on by different sets of workmen: one relates to the "body," and the other to the framework or "carriage;" the former depending more upon delicacy, and the latter upon strength. In bending thin pieces of timber to form curved panels, the wood is wetted on the side which is to be convex, and heated on that which is to be concave: the unequal expansion of the two surfaces —or rather, the expansion of the one and the contraction of the other —produce the curvature, and it is the workman's business to secure this curved form when once obtained. With a few exceptions, the processes connected with coach-body making may be regarded as very similar to those of cabinet-making.

In the making of the carriage which supports the body, the flat surfaces are so few in number that the plane is scarcely employed; after the saw, the chief cutting instrument is a hand-tool resembling a spoke-shave. The complexity of the framework, and the number of pieces which compose it, depend a good deal on the circumstance whether the carriage has four wheels or only two, and whether drawn by one or two horses. In the Dennet and the Stanhope, two-wheeled vehicles drawn each by one horse, there is very little underframing. In the Tilbury and the Cabriolet, pliable leathern braces are introduced between the springs and the body of the vehicle. All these four have shafts; but in the Curricle, a two-wheeled vehicle for two horses, now almost extinct, there were no shafts; the body was suspended on a frame consisting of two side-pieces and two cross-bars at each end; a pole inserted in this frame served to yoke the horses to the vehicle. Where there are four wheels, the underframing is more complicated, since the wheels have to be connected one with another, and also with the body. In some vehicles of this kind, there are elliptical springs beneath the body and the axle; while in others, besides these springs, there are pliable leathern braces to connect the body with the under-framework; in which case the framework which supports the fore and hind springs is connected together by a long central piece of timber called the perch. Occasionally this perch is made of iron, and is bent into a form called the "crane-neck," as a means of enabling the coach to be turned more readily in a narrow street. The general class of four-wheeled carriages for two horses, such as the coach and the chariot, have double sets of springs: namely, horizontal springs immediately on the axles, to support the carriage and to intercept the concussion; and circular upright springs to sustain the body. If made close, such carriages comprise the varieties of the Coach and the Chariot; if to open occasionally, the Landau and the Landaulet; if to remain permanently open with a leathern hood or head, the Barouche and the Barouchet; and a modification of this latter kind, the Britzscha. All these varieties of form render necessary corresponding changes in the formation of the framework beneath. The form and nature of the springs above alluded to are described in SPRINGS. Many coach-makers now make use of gutta-percha and vulcanised India-rubber, in parts where toughness and elasticity are needed.

The arrangements of the under parts of the mechanism depend a good deal on the facilities afforded for turning the coach. In a four-wheeled carriage there is an axle connecting the two fore-wheels, and another connecting the two hind-wheels; and if these two axles were so fixed as to remain constantly parallel, the carriage could not turn. In practice, the front axle is made to turn upon a pivot, and the wheels connected with it are made small enough to go under the framework of the carriage during the act of turning. It is for this reason, and this alone, that the front wheels are made smaller than the hinder ones; and as a great disadvantage in draught is thereby occasioned, various contrivances have been adopted for rendering the use of somewhat larger wheels practicable. Sometimes the body of the carriage is raised to a greater height; sometimes a portion of the under part of the body is cut away, to leave room for the turning of the wheel. It was as a means of remedying these inconveniences that Mr. Adams proposed the "æquirotal" construction of carriages. As the inequality in the sizes of the fore- and hind-wheels is adopted solely as a means of enabling the vehicle to be turned round, Mr. Adams sought for some mode of enabling this turning to be effected even when all the four wheels are of equal size. This he does by having the carriage so divided in the middle as to turn upon a pivot; or rather, the pivot, or perch-bolt, which in a common carriage is placed immediately between the two front wheels, is on the æquirotal principle placed much farther back, by which the fore-wheels have so large a radius in turning that they do not touch the body, and may therefore be made of equal size with the hinder wheels. The mode of adjusting this pivot depends upon the kind of carriage. In a phaëton, which is an open four-wheeled carriage with two seats, the front one higher than the lower, the hinder half of the body is hinged to the front half. In a chariot or a coach, the coach-box is connected with the framework of the front wheels, and the body with that of the hind wheels, and there is a pivot which connects the two halves together. There is great ingenuity in this æquirotal system, but it has not come largely into use.

The axles of a carriage form an important part of the manufacture, since they are the medium of communication from the wheels to the body. When this part of the mechanism was made wholly of wood, its general designation was "axle-tree;" but iron is now more extensively

used, and the name "axle" is given to it. Formerly the axle was made to revolve with the wheels, but now the wheels are generally made to revolve on and not with the axle. There are three parts in the axle,—the two "arms," which pass into the naves of the two wheels, and the "bed" or central part, which connects the two arms. The adjustment at the nave or centre of the wheel requires very careful management; and it is to this point that Collinge's "patent axle" chiefly relates. In earlier modes of construction a ring was put within the hollow of the nave, and the end of the arm of the axle worked within this ring,—an arrangement which was intended to prevent the too rapid wear of the wood by the friction of the axle. In the present practice, however, the axles are fitted with iron boxes adjusted to the arms. To lessen the friction arising from the two surfaces working together, black lead, soap, grease, or oil is used; and it is partly on account of the ingenious way in which this lubrication with oil is effected, that Collinge's "patent axle" is so much employed. Besides the mechanism for connecting the axle with the wheel, there is contained a little cup for holding oil; and as the wheel rolls along, this oil is pumped or drawn out of its receptacle, and made to lubricate the adjacent surface.

In a well-finished coach, the *leathering* and the *painting* are among the more important processes after the wood and iron work are completed. The former of these is somewhat remarkable. In the common kinds of vehicles the wood and iron are coated with paint laid on to a considerable thickness; but for the better kinds, leather is applied to the roof, and the upper part of the back, front, and sides, previous to the process of painting; this is done chiefly to shield the wood-work from the alternations of heat and rain. A singular example is here shown of the pliability of leather; for one hide, without seam, knot, or joining, is made to cover the whole. "The hide, which is of a large size and sound quality, is first thoroughly moistened and thrown over the top of the coach, the edges hanging down on all sides. The currier then rubs or presses it down all over the roof, until it lies close and even in every part. He next proceeds to one of the sides, and in like manner rubs and scrapes the leather till all irregularities disappear. The leather is in that soft and pliable state that it will yield to the movement of the tools, and enable the workman to fit it to every part of the coach with perfect closeness. A little consideration must show that a superfluous fold of leather will occur at each corner; yet by working it towards a central point at the back or front, the currier succeeds in erasing or pressing out all irregularities, and in producing a surface sufficiently flat and smooth for the subsequent operations of the painter. The division between the upper and lower portions of a coach is usually covered by beading of some kind or other, and the leather is trimmed or cut to this line of division." ('Penny Magazine,' No. 625.) Any cut or crack in the leather, however small, would be fatal to the success of this remarkable mode of covering coaches.

A coach receives a far thicker coating of paint than the wood-work of a house, since it could not else admit of the very high polish to which it owes so much of its beauty. The principal plain surfaces, such as the doors and panels, receive ten, twelve, or even fifteen distinct coatings, each one thoroughly dried before the next is applied; and at intermediate times all the roughnesses derived from the paint are smoothed down by pumice-stone, rotten-stone, and other like substances. The leathered top, in the best coaches, sometimes receives as many as twenty-five coatings of paint. The paint, which is formed from nearly the same materials as that used for house-painting,—namely, mineral colours, linseed-oil, and turpentine,—is of a white colour for the earlier coats, a yellowish tint for those next applied, and depends for its tint in the later coatings on the taste of the maker. All these several coatings being dried and smoothed, the surfaces receive six or eight applications of copal varnish; and it is the subsequent polishing of this varnish which imparts the smooth, lustrous, and beautiful appearance to the panels and plain surfaces.

Mr. Hooper, a practical coach-builder, in a paper recently read before the Society of Arts, drew attention to several interesting matters connected with his art. Of these, we will notice three,—relating to the classes of work-people employed in coach-making, the kinds of lace and silk required in finishing a carriage, and certain desiderata among coach-builders. On the first point he said: "Carriage-workmen are divided into separate classes and trades. There are *body-makers*, who form and make the part in which the persons sit; *carriage-makers*, who make the under works, apply the parts necessary for backing or turning the carriage, fix the axles and springs, &c.; *wheelers* or *wheelwrights*; *joiners*, who make the glass-frames, blinds, boxes, trunks, &c.; *fitters*, who fit and suspend the bodies on the under works, and apply the various parts furnished by special manufacturers, such as lamps, handles, &c.; *body* and *carriage painters*; *trimmers*, who fit up the insides of carriages, and fix the silks, cloth, and laces in the necessary parts; *leather-workers*, divided into *cutters*, *sewers*, *seat-trimmers*, and *harness-makers*, according to the different works they are engaged upon; *smiths*, divided into *carriage-smiths*, *body-smiths*, *tyre-smiths*, and *spring-smiths*; *vicemen*, who chisel and file the iron-work made by the smiths; *carvers*; *sawyers*; *polishers*, who produce the brilliant polish on carriage panels; *herald painters*; *caners*, usually women, who interlace the neat cane-work now so fashionable on carriage panels; and *liners*, women who sew together the cloth, silk, lace, &c., after being cut out by the trimmers." Concerning the silk and lace used in coach-making, Mr. Hooper said: "Formerly a kind of silk called lutestring was in use. This was superseded in England by a strong ribbed silk called tabaret. After a time, this tabaret was copied in France, where the manufacturers considerably improved it by overcoming a difficulty, and producing a figure on the surface. This, in its turn, was copied in England (about 1848), with much success, and has now almost superseded all other kinds for carriages; it is called *reps* in France, and *boscatelle* in England. The improvement in this kind of silk goods has been so rapid in England for several years past as to have overtaken the French fabricants, with a good chance of surpassing them in quality at a lower price. Carriage laces appear to have been made for many years in this country of a quality far superior to the foreign laces; they [the foreigners] have, however, now succeeded in making them of excellent quality. The Germans have been introducing a considerable quantity of good lace into this country for some months past, at a very reduced price compared to English-made laces; this however will probably be soon counteracted, as it has caused some enterprising manufacturers in Coventry to establish improved looms for this department of weaving, and to produce goods of equal quality at somewhat lower prices." Mr. Hooper's remarks on desiderata were to the following effect: "We are in want of several improved materials and appliances to facilitate the manufacture of carriages. Among the former, are,—colourless oils for painters' use; a colourless varnish (all the copal varnishes now in use having a brown tinge, which is injurious to delicate colours); a durable ultramarine blue; and cheaper and more durable lakes. Among the latter [class of desiderata], is a machine for sewing leather for carriages and harness: though various attempts have been made, they have up to the present time been unsuccessful, as they will not work with a strong waxed thread, or draw the stitches sufficiently tight. A machinist producing such a machine at a reasonable price would have a large demand for them; seeing that, besides the great quantity of leather-sewing required for carriages and carriage-harness, saddlery, army accoutrements, and military harness would lay claim to its assistance."

COAGULATION, the solidification of a liquid produced without evaporation and without crystallisation. It is also often effected without reducing the temperature of the substance coagulated, in which it differs from mere congelation.

Coagulation occurs in various ways in different fluids. Thus when albumen, or the white of egg, is heated, it is rendered solid, or it coagulates. The spontaneous coagulation of the blood, by which it is resolved into serum and coagulum has already been noticed. [Blood, Nat. Hist. Div.] The cause of the coagulation of casein by the action of rennet on milk, is as yet unexplained. Acids induce the curdling of milk by neutralising the alkali by which the casein is held in solution.

There are some cases of pure chemical action which resemble coagulation in appearance; when, for example, solutions of sulphate of soda and nitrate of lime are mixed, a sudden solidification takes place; but this is a case of confused crystallisation, and not of coagulation.

COAL TAR. When coal is heated in close vessels [Gas, Manufacture of) a large quantity of gas is evolved, from which on cooling there separates out a dark coloured, badly smelling, treacle-like substance, called coal-tar. It possesses very considerable interest from the fact, that by distillation it furnishes a number of compounds now almost indispensable in the arts and manufactures. For this purpose large quantities of it are heated in immense iron stills. The portions that first distil over, constitute, when rectified, *coal-naphtha*, so important as a solvent of india-rubber and gutta-percha. The second portion of the distillate, about 30 per cent., is technically known as *heavy naphtha*, *coal oil*, or *dead oil*: it is used as a lubricating agent, and on account of its antiseptic properties is employed to preserve timber; thus railway sleepers soaked in it resist the action of air and moisture for a far greater length of time than usual. Coal-oil is also largely used for burning into the lampblack with which printer's ink is made. The residue in the retort, after the naphtha and coal-oil are entirely volatilised is *pitch*, used in forming asphalte pavements, and in the manufacture of black japan for varnishing iron-work.

Coal-tar mixed with the coal dust formerly wasted in mining operations forms an excellent artificial fuel; it is usually rendered compact and portable by being pressed into the form of square blocks.

Finally, colouring matters and perfumes may be obtained from coal-tar, though at present not in all cases economically.

Naphtha, coal-oil, and pitch, are each of them mixtures of several definite chemical compounds, and by careful rectification, &c., may be separated from each other. They are usually divided into three classes, basic, acid, and neutral. The following is a list of those that have been examined:—

Bases.	Acids.
Picoline.	Acetic.
Leucoline.	Carbolic.
Aniline.	Brunolic.
Pyridine.	Rosolic.

Neutral substances:—

Liquid.	Solid.
Benzole.	Paraffin.
Toluole.	Naphthalin.
Cumole.	Paranaphthalin.
Cymole.	Pyren.
	Chrysen.

They will be found more fully described in their respective alphabetical places.

Reichenbach has also noticed, and partially examined, three other substances: *pittacal*, a deep blue coloured solid; *picamar*, a bitter oil, sp. gr. 1·1; and *cedriret*, which crystallises in orange-red needles from a solution of persulphate of iron. Greville Williams has also isolated several *radicals of alcohols*, or their *hydrides*, including *tetryl* and *amyl*.

COAL TRADE. In the article COAL, COMPOSITION OF, in the NATURAL HISTORY DIVISION of this Cyclopædia, an account is given of the chemical constituents of different kinds of coal; in the article COAL FIELDS, in the same division, a full description is given of the chief deposits of coal in our own and in foreign countries; lastly, under the head of MINING, COAL, in the present division, will be found a description of colliery operations. In the present place, therefore, it will suffice to trace some of the more remarkable features in the coal trade of this country; with a notice of some of the circumstances which have led to a rapid augmentation of that trade.

In 1816, a committee of the coal-owners of Northumberland and Durham was commissioned to inquire into the quantity of coals at that time sent by road and canal, from the pits of these two counties to other parts of the kingdom. The quantity was ascertained to be nearly 11,000,000 tons. But this estimate took no account of the sea-borne coal to London, nor of the coal consumed in and near the busy towns of the north. Twenty-five years ago it was estimated that Sheffield alone consumed half a million tons, drawn from neighbouring pits; and that the iron-works of the midland counties consumed five million tons. The statistical returns were, however, very inconclusive; for the estimates of total consumption in the United Kingdom, in all localities and for all purposes, varied between the wide limits of fifteen and thirty million tons. About the year 1830, a great authority on mining subjects, Mr. Taylor, made the following estimate:—

	Tons.
Coals sent coastwise from Northumberland and Durham	3,300,000
Home consumption in Northumberland and Durham	660,000
Produce of other counties for domestic purposes	7,920,000
Consumed in iron-works and Cornish mines	3,000,000
Exported to Ireland	700,000
	15,580,000

This was exclusive of the exports to foreign countries. Other inquirers, about the year 1835, felt assured that the quantity was higher than Mr. Taylor had estimated. One tabulation, carefully prepared so far as data were obtainable, gave the following result:—

	Tons.
Sent coastwise from Northumberland and Durham	4,368,000
Home consumption in Northumberland and Durham	870,000
Produce of other counties for domestic use	10,480,000
Consumed in iron-works and Cornish mines	6,000,000
Exported to Ireland	1,000,000
Waste by screening	6,630,000
	29,348,000

Later estimates, based on surer grounds, we will advert to presently.

It was long considered by the legislature politic to check the exportation of coals to other countries; both through fear of exhausting the mines, and because it was imagined that our superiority as manufacturers might be endangered. Coal was also, on many occasions, made a source of revenue to the state, a source of revenue to the corporation of the city of London, and a perquisite to certain pampered minions of the court. The national tax was sometimes on exported coal, sometimes on coal carried coastwise. The London tax is a corporate privilege, granted by virtue of several acts of parliament, for several alleged reasons; it amounts to about a shilling a ton, and is levied on all coals brought into London, or within a certain radial distance of it. There is a probability that this tax, in its appropriation, if not also in its amount, will shortly undergo modification. The Tyne tax, or Richmond tax, was a perquisite granted by letters patent from Charles II. to the Duke of Richmond, amounting to one shilling per chaldron on all coals shipped from the Tyne to the Thames; the descendants of the duke received this perquisite until the year 1799, when it was found to amount to about 21,000*l.* per annum; it was commuted for a perpetual annuity of 19,000*l.*, chargeable on the Consolidated fund.

The coal-owners of Northumberland and Durham, looking to London as its best customers, maintained for many years a remarkable compact, tending to keep up prices. Railways have now nearly broken down this monopoly, but it may be well briefly to state its nature. In 1771, the owners of the greater part of the collieries in the counties of Durham and Northumberland entered into a mutual agreement, under the denomination of "The Limitation of the Vends." The object of this compact was to apportion among the different collieries the quantity to be raised and sold, according to the quality of the coal and the power of raising it, and with reference also to the probable demands of the different markets in the kingdom. A representative was named for each of the collieries: these representatives met together, and from amongst them chose a committee of nine for the Tyne, and seven for the Wear. This being done, the proprietors of the best coals were

called upon to name the price at which they intended to sell their coals for the succeeding twelve months; according to this price the remaining proprietors fixed their prices. This being accomplished, each colliery was requested to send in a statement of the different sorts of coal they raised, and the powers of the colliery, that is, the quantity that each particular colliery could raise at full work; and upon these statements the committee, assuming an imaginary basis, fixed the relative proportions as to quantity between all the collieries, which proportions were observed, whatever quantity the markets might demand. The committee then met once a month, and according to the probable demand of the ensuing month they issued so much per 1000 to the different collieries. This demand was determined wholly by the price in the London market. If this had been greater during the previous month than the price fixed by the coal-owners, as already explained, added to the freight and other charges of conveyance to London, permission was given to raise a larger quantity; and on the contrary, if the price had been below a remunerative one, thus calculated, then the supply was limited till the requisite price was reached. In the agreement entered into among the owners of collieries, it was stipulated that no one without leave of the committee should sell below the fixed price agreed on as the price to be charged by such colliery: and arrangements were made for enforcing penalties for any breach of this agreement. The policy or impolicy of the "Limitation of the Vends" was for many years very fiercely contested,—the colliery interest regarding the practice from a protective point of view: while the inhabitants of the metropolis were naturally favourable to a free-trade policy. It is unnecessary to follow the line of argument used by either side; for the system has gradually yielded to the power of railways, which now bring up coals cheaply to London, from districts which were formerly wholly shut out from this important market.

Another regulation affecting the coal trade from the Tyne and the Wear was established by Act of Parliament (6 Geo. IV. c. 32), under the provisions of which every ship must be loaded in her turn; and if any colliery refuse to sell, a penalty is imposed of 100*l.* This regulation was, however, evaded by the coal-owners towards ships the owners of which refused to be bound by their regulations in the port of discharge. The mode of evading it was to fix an exorbitant price upon their coal, which might be done although a price below the regulation was not allowed; by this means the vessels were either brought into conformity with the regulations in the port of discharge, or forced out of the trade. The factors and colliery-owners, again, still find it convenient among themselves to make regulations concerning the number of ship-loads of coal that shall be offered for sale on one day, and the order in which the several collieries shall be represented; but all such compacts, like the limitation of the Vends, have been much affected by the extension of railways.

In 1836 there were 47 collieries on the Tyne, 17 on the Wear, and 16 on the Tees. The Tyne and the Wear were at that period jealous of the Tees, which was beginning to ship large stores of inland coals brought down to Stockton by railway; and attempts were made, with partial success, to check the further construction of railways in the two counties. Seven years afterwards, in 1843, the colliery proprietorships were ranged under four classes, according to the scale of the operations. The 1st class comprised four great concerns, headed respectively by the Marquis of Londonderry, the Earl of Durham, Lord Ravensworth, and the Hetton Coal Company. The capital sunk in each of these concerns was supposed to be not less than half a million sterling; they each comprised from six to twelve separate mines, and all the necessary engines, waggons, horses, &c.; and they were believed to realise a profit on an average from 35,000*l.* to 45,000*l.* per year each. The 2nd class comprised companies or partnerships whose sunken capital ranged from 100,000*l.* to 200,000*l.* The 3rd class included those concerns which had only a single pit each, and whose capitals ranged between 40,000*l.* and 60,000*l.* The 4th class, humbler but more numerous than any of the others, comprised those which had a capital ranging from 8000*l.* to 30,000*l.* In that year, in Durham county, there were more persons employed under ground in coal-mines than above ground in agriculture. The following figures referred to a particular day in the year 1843, and to all the collieries on the Tyne, Wear, and Tees:—

	On the Tyne.	On the Wear and Tees.
No. of collieries	41	29
No. of pits	92	100
Average depth, in fathoms	85	75
No of men and boys employed	12,833	12,937 (in 27 collieries)
Engine-power in pumping water	4,888 horses	9,707 (in 23 collieries)
Engine-power in raising coals	4,782 ,,	
Coal raised per annum	2,468,481 tons	2,355,486 (from 22 collieries)
Highest price at that date	10*s.* 1½*d.* per ton	11*s.* 6*d.* per ton
Lowest price at that date	7*s.* 1*d.* ,,	8*s.* 6*d.* ,,

The coal-mining arrangements, in relation to wages and labour agreements, differ in different counties. In South Staffordshire and the neighbouring coal-fields, the "Butty" system is extensively acted on. This consists in the miners being the servants, not of the proprietor or lessee of a colliery, but of a contractor called a "butty," who

engages with the proprietor of the mine to deliver the coal at so much the ton; hiring the labourers himself, using his own horses, and supplying all the tools necessary for working the mines. These butties have in general been working miners, who, by the accumulation of some little capital, or by the assistance of relations, are enabled to engage a pit, with or without partnership with other persons, and to enter into a bond to raise the coal at a given price per ton. "The butty," says Mr. Tancred, in a Report on the coal trade, "has become the middleman or task-master, and the pit's company his hired labourers, from whom it is his interest to squeeze out as much profit by any and all means as circumstances will allow. The man of property, who possesses the royalty, sinks the pits, and erects the machinery, and whose position therefore in society would ensure in general humane and liberal treatment of his labourers, is by the intervention of a butty entirely disconnected with them; he neither hires nor dismisses them from his mine, but hands the whole concern over, as far as the employment of the labouring classes is concerned, or any interest in their welfare as his servants, to an inferior." The miners entertain a bitter dislike to the "butty" system, and many of the proprietors are endeavouring to abolish it. In the Northumberland and Durham district, the relation between the proprietors and the miners is more direct and intimate. No middlemen or contractors are employed; the overseers, viewers, and other intermediate officers, are paid by regular salaries; and the working colliers receive in cash from the proprietors, once a fortnight, the amount of their earnings. There is a bond or agreement between the parties, differing from the "butty" system of Staffordshire, and also from the "tutwork and tribute" system of the Cornish mines. [MINING.] This bond is annual, and by its terms the miner is ensured a minimum amount of wages, generally to the extent of seven or eight days per fortnight, which the owners are bound to pay the men whether the mine be working or not; beyond this minimum, whatever work the miners may do is paid for at a stipulated price. The wages are paid for the quantity of coals raised. This northern system however, like the limitations of the vends, has been much affected by railway rivalry.

Until recent years, women and children were largely employed in coal-mines. In Northumberland and Durham there were nearly as many women and children as men in the pits; and in Lancashire and Yorkshire a much larger ratio. The statements made public concerning the condition and treatment of these women excited much attention about eighteen years ago, and led to the passing of an Act of Parliament in 1842 (5 & 6 Vict. c. 99), of which the following is a brief abstract: From the time of passing the Act no female, other than such as were so employed previously, was to work in any mine or colliery; and that after three months from that date, no female under eighteen years old should be so employed; nor any female whatever after March 1, 1843. After this latter date, no males were to be employed under ten years of age. No person to be apprenticed under ten years of age, nor for longer than eight years (except in the case of engine-wrights and others who are only occasionally at work under ground). Where there are vertical or other shafts, no steam or other engine to be intrusted to the care of a person under the age of fifteen; in the case of a windlass or gin worked by a horse or other animal, the driver to be considered the person in charge. After three months from the passing of the Act, proprietors of mines or collieries not to pay workmen their wages at any tavern or public-house. To enforce the observance of these regulations, the following arrangements were made: Inspectors of mines and collieries, appointed by the Secretary of State for the Home Department, are empowered to enter and examine any such works, and to report concerning them to the government; any proprietor violating the law as to the age and duration of apprenticeship, is subject to a fine varying from 5*l.* to 10*l.*; parents or guardians misrepresenting the age of children so employed are fined 40*s.*; a neglect of the clause as to the care of the shafts, and also of that relating to the payment of wages, subjects the offender to fines varying from 5*l.* to 50*l.* It was found, as might have been expected, that many young persons were for a time thrown out of employment when this act came into operation; but the evils resulting from the former system were too great to be overlooked.

The question respecting the available store of coal in this island has been much canvassed. Mr. T. Sopwith, in an Essay published in 1844 ('The National Importance of Preserving Mining Records'), remarks: "The opinion that our stores of coal are all but inexhaustible, rests wholly on assumed data, and not upon an accurate and detailed statistical account, such as alone could warrant a confident opinion. This question will ere long become a subject of serious concern, unless some measures are taken to found our calculations on a solid basis. It is an easy matter to assume that a considerable thickness of available coal extends over hundreds of square miles; but the different opinions formed by men of the highest respectability and talent, strongly prove how meagre and unsatisfactory are the only data on which these estimates are founded. It is not, however, the mere quantity of coal that is to be considered. Especial regard must be had to its quality, depth, thickness, extent, and position. Many of the inferior seams can only be worked in conjunction with those which, by their superior quality, repay the expense of working them at depths varying from 300 to 600 yards; and it may readily be conceived, that inferior coal only could not be profitably raised from pits equal in

depth to three or four times the height of St. Paul's Cathedral, unless the price of such inferior coal was raised to more than the present price of the best coal. . . . . It is not the exhaustion of mines, but the period at which they can be profitably worked, that merits earnest and immediate attention." These remarks, from a man who is well acquainted with the subject, are worth more than the vague assertions made by some geologists and writers on statistics. In this as in other branches of industry, we must not only consider the possible amount of supply, but also the price at which the thing can be brought to market. It is supposed that the total yield of all the collieries in the United Kingdom is about 50 million tons yearly. In 1854 the Northumberland and Durham yield was about 14 million tons; of which, 6½ millions were shipped coastwise, 2½ exported, 2½ converted into coke, 2⅓ consumed locally. This produce would have covered with a layer an inch thick a road a thousand miles long by six yards broad.

In relation to the coal-trade of recent years, three circumstances must be taken into account,—the effect of the removal of the duty, in increasing the amount of export; the effect of railways, in increasing the supply and lowering the price; and the effect of screw-collier steamers, in expediting the transport and lowering the price. We shall offer a few remarks on all these points.

The coal duties were repealed in 1835, so far as concerned coals exported in British ships; while the duty on those exported in foreign ships was reduced. Great activity followed, for ships were now enabled to carry out coal instead of ballast to foreign countries. The exigencies of the state led to a re-imposition of the duty in 1842; this at once checked the foreign trade, which did not recover itself till the final removal of the duty in 1845. The trade had been gradually growing, from about 370,000 tons in 1827; 740,000 in 1835; to 1,600,000 in 1840, and 2,000,000 in 1842. The discouragement brought it down to 1,700,000 in 1844. After the final removal of the duty, the trade extended in the following remarkable way:—

1846	
1848	2,531,108 tons.
1850	2,785,301
1852	3,351,880
1854	3,640,194
1856	4,309,255
1858	5,879,779
	6,519,956

These figures are very significant, showing how rapid has been the advance in this department of our export trade. These returns include culm and coke as well as coal. The extent to which different foreign countries are our customers for fuel may be illustrated by the figures for the year 1858:—

Russia	
Denmark	314,082 tons.
Prussia	382,604
Hanse Towns	409,402
France	521,405
Spain	1,332,241
Turkey	331,818
United States	187,430
Malta	300,707
West Indies	118,325
Other countries (about)	90,134
	2,500,000

The extent to which different collieries contributed towards these figures, in 1858, may be thus shown:—

From Tyne, Wear, and Tees	3,600,000 tons
„ Yorkshire	250,000 „
„ Liverpool	470,000 „
„ South Wales and western counties	1,400,000 „
„ Scotland	380,000 „

leaving about 400,000 tons from other parts.

The London consumption of coal is by far the most remarkable feature in the trade. In 1814, when the price of coal was 13*s.* per ton at Newcastle and Sunderland, it was as high as 44*s.* in London,—so heavy was the coasting duty, and so large the profits of the colliers, owners, and all concerned. In 1834, when the Newcastle price was 10*s.* 9*d.*, the London price was 19*s.* This addition of 8*s.* 3*d.* was made up of an immense number of items, including freight, weight office, entry, City dues, metage, scorage, factorage, commission, insurage, policy duty, and delivery charges. In the year just named, London bought 2,300,000 tons of coal, which required the services of 8000 ships. In 1842 the quantity amounted to 2,700,000, in addition to a small quantity of canal. The Great Northern Railway has been the chief agent in bringing about an improved supply of coals to London; the directors made arrangements with colliery owners in Yorkshire and other counties, by which inland coals could be brought to the metropolis at a very low price: a double consequence followed,—other railway companies have adopted a similar system in relation to other counties, and the Northumberland and Durham colliery owners have been brought into a state of healthy competition. Their limitation of the vends was brought to an end in 1845, even before the railway system had developed its powers in the coal-trade. By the year 1853 the sea-borne coal to London had increased to 3,400,000 tons (about 11,000 shiploads), and the railway transport nearly reached 1,000,000 tons. In 1857 the quantities were—3,160,000 tons brought by sea, and 1,230,000 tons by railway and canal: showing a steady rise in the inland mode of conveyance.

The coals brought to London by sea are mostly in collier sailing-brigs. The competition in the trade, however, has in late years led to a new mode of transport, by screw steam-vessels. From a paper read before the Institution of Civil Engineers in 1854, it appears that, about that date, the screw-colliers in use carried about double the average cargoes of sailing-colliers, and were capable of making thrice as many voyages in a year. An average screw-collier, therefore, did six times as much work as a sailing-collier. A sailing-collier, carrying 300 tons, and making ten voyages in a year, might be bought for 1200*l.* to 1800*l.*; and six of them would about equal in cost one screw-collier, carrying 600 tons, and costing 10,000*l.* Then, on comparing all expenses attending the carrying of 18,000 tons of coal to London, those of the screw-collier amounted to 5050*l.*, while those of the six sailing-colliers amounted to 6420*l.* The sunk capital being about equal in the two cases, and the working expenses exhibiting the ratio here mentioned, the difference amounted to 1*s.* 6*d.* per ton, or 20 per cent., in favour of the screw-collier. Sailing-colliers, worked on the most approved principles, could bring coals from the Tyne to London at 5*s.* 3*d.* per ton; whereas screw-colliers could do the same work for 3*s.* 6*d.*,—the same rates being taken for both in relation to wages, provisions, and stores. It was argued, in the discussion which followed the reading of the paper here adverted to, that screw-colliers are indispensable to the serving of a steady and efficient supply of sea-borne coal to London, combined with good collier-docks at both ends of the route (such as the admirable Victoria Dock at North Woolwich). Vast fleets of sailing-colliers are sometimes detained in the Tyne by adverse winds, or by want of water on the bar; then, on a change of weather, they all set sail together, and arrive at the Thames in a very cloud of sail, where perhaps they have to beat up a hundred miles of river against wind and tide. Hence the variation of supply, followed by variation of price. The cure for this would be a powerful fleet of screw-colliers, constantly and punctually running, with commodious docks at both ends of the route, and all the best modern facilities for rapid discharge by steam-cranes instead of coal-whipping. Experience, however, has not altogether confirmed the anticipations of the steam-collier projectors. The sailing-colliers, it is found, can yet do the work more cheaply on the whole.

The question has been much discussed, whether the use of screw-colliers would realise one of the objects sought to be attained by vastness of size in reference to the ship Leviathan, or Great Eastern. Ordinary steamers, going to the Cape, to India, or to Australia, are obliged to stop on the way to take in coals; and as native coal is not found on the coaling stations, a supply has to be taken from England. This supply is conveyed by sailing-colliers, and the price of coal hence becomes enormous at the more distant stations. To obviate this evil, the projectors of the Great Eastern planned a ship so large that it can carry a supply of coal sufficient for a voyage to Australia and back. The question now is, whether the capital expended in building the coal-storing part of this enormous ship would not be better applied in building and working a certain number of screw-colliers, making seven or eight knots an hour. Some engineers contend that, at the average rate of freights, wages, and provisions, screw-colliers must be more profitable than the use of an immense ship, in which the coal occupies useful space which could otherwise be available for cargo. The approaching completion of the Great Eastern (August, 1859) will doubtless prepare the way for the collection of valuable information on this important question.

Since 1854 the use of screw-colliers has been adopted, not only on the Tyne and Thames route, but in other directions. In 1857 one was built to carry coals from Cardiff to London; it could take 1500 tons, exclusive of 150 tons to use as fuel. The hull was of iron, and there were arrangements for carrying 400 tons of water-ballast in the bottom, which could be readily pumped out when the ship arrived back at Cardiff. The ship cost 23,000*l.*, and the intention and hope of its owners were, that it would enable them to underbid the South Wales and Great Western railways in bringing Cardiff coals to London.

Concerning the actual cost at which coals can be placed on a railway from pits not far distant, an interesting calculation was made early in 1859, relating to some collieries in the Forest of Dean. It was estimated, that of 250 tons placed on the Great Western Railway, 95 tons of block coal could be delivered there at 8*s.* per ton, 70 tons of rubble coal at 6*s.* 6*d.*, and 85 tons of lime-coal at 2*s.*, being 69*l.* 5*s.* in all. The total cost was 45*l.* 6*s.* 3*d.*, or 3*s.* 7½*d.* per ton, thus made up:—

	s.	*d.*	
Cutting the coal in the mine	2	0	per ton
Loading and rolling to pit's bottom	0	1	
Pit-work, with timber and stone	0	3	
Tram-plates and iron-work	0	2	
Rope, tar, oil, and engine expenses	0	1	
Breaking and hitching	0	2	
Royalty or Rent to the Crown	0	2	
Management	0	1	
Conveyance on tram to Great Western Railway	0	4	
Loading in railway trucks	0	2	
Wear and tear of trams and machinery	0	0½	
Incidental expences	0	1	
	3	7½	

The cost to the consumer, beyond the price of 8*s.* per ton for block coal, would depend on the railway charges and the dealers' profits.

One or two other interesting matters concerning the coal trade of the metropolis may here be mentioned. Between the years 1807 and 1831 the corporation of London were owners of a Coal Exchange, kept up for their own profit; but in the last-named year an Act of Parliament converted the Coal Exchange into an open coal market, to be governed on certain regulations. The same Act defined the privileges of the corporation in certain matters relating to the coal trade; and most of these privileges were further sanctioned by subsequent statutes. A new Coal Exchange was built in 1849, under arrangements very convenient for sellers, buyers, and factors. The "whipping" of coals is a strange part of the coal-trade. The coal-whippers are labouring men, who "whip" or transfer the coals from the collier-brigs to barges, which barges generally carry them to wharves at the river side. The work is simply shovelling and hauling; but the men, several years ago, fell into the hands of publicans and others, who acted as middlemen, contracting with a captain or coal-owner to whip a ship of coals at a certain price, and then employing the men at a smaller price. By a kind of tally system, the men were drawn in to spend nearly all their earnings at shops belonging to the middlemen, for inferior goods supplied at high prices. The legislature has attempted to remedy this evil, but without much success; for if the men are not free agents in their dealings, the law cannot make them so. In 1851 Messrs. Prior introduced a mode of whipping coals by steam-power, and such will probably be the general mode after a time; but hitherto the hand method has prevailed.

COBALT (Co). One of the metallic elements. It does not occur naturally in the free state, but usually combined with arsenic, forming arsenide of cobalt (Co As). In mineralogy this ore is known under the names of *speiss cobalt*, *tin-white cobalt*, or *smaltine*. Cobalt is also not unfrequently found as *cobalt-glance*, or *bright white cobalt*, a combination of arsenide and sulphide of the metal (CoS_2, CoAs). Other ores of cobalt have already been described, and their composition detailed. [Cobalt, Nat. Hist. Div.]

Metallic cobalt may, by somewhat tedious processes, be obtained from its ores. On account of the difficulties attending its reduction its properties have not been very thoroughly investigated, and consequently it has not yet received any application in the arts. For experimental purposes it may be prepared from the oxalate. The latter placed in a porcelain crucible, enclosed in a very refractory earthen one, and heated in a powerful wind furnace, will usually yield a button of the pure metal.

Cobalt is hard, brittle, and almost as infusible as iron. Its colour is reddish grey; it is magnetic, and has a specific gravity of about 8·9. It is soluble in dilute sulphuric or hydrochloric acids, with evolution of hydrogen. It tarnishes when exposed to the air, and is rapidly oxidised by nitric acid.

Equivalent of cobalt, 29·5.

The compounds of cobalt are remarkable for the beauty of their colour, and on this account have been used from the time of the ancient Greeks to the present day.

Zaffre is the name given to the compound of cobalt that occurs in commerce. It is a very impure oxide of the metal, and is produced by roasting the crushed selected ore on the sole of a reverberatory furnace, the sulphur burns to sulphurous acid, and passes off as gas, while the arsenic, oxidised to arsenious acid, is volatilised, and condenses in the long horizontal flues. The ore is finally ground to fine powder with two or three parts of pure siliceous sand. The product thus obtained is largely used in the manufacture of stained glass, principally to give the well known rich blue colour; it is also extensively employed in the ornamenting of pottery ware.

Smalt is a very finely ground deep blue glass, manufactured chiefly in Saxony. For this purpose the cobalt ore is only partially roasted, the object being to oxidise the cobalt only; the product is then mixed with about an equal quantity of carbonate of potash and twice its weight of well ground calcined quartz, and the whole melted together in suitable pots by the heat of a powerful furnace. In a few hours the silica of the quartz, and the potash combine to form a liquid mass of silicate of potash in which the oxide of cobalt dissolves, while the sulphides and arsenides of nickel, bismuth, and other metals, sink to the bottom of the vessel, there fuse, and under the name of *speiss*, are afterwards made use of as a source of the metal nickel [Nickel]. The clear blue glass, after being skimmed, is ladled out of the pots and poured into water, by which it is so suddenly cooled that it instantly splits up into innumerable fragments; it is further minutely divided by grinding with granite stones under water, and the particles separated into different degrees of fineness by elutriation. Smalt is principally used as a pigment by paper-stainers.

Cobalt and *oxygen* form two well-marked oxides, the *protoxide* (CoO) and the *sesquioxide* (Co_2O_3). Some unimportant intermediate oxides also exist.

Protoxide of cobalt (CoO), eq. 37·5. As this oxide is an important article of commerce, being used to a considerable extent for enamel painting, it is prepared on the large scale from zaffre. The zaffre is dissolved in nitric acid, the solution evaporated nearly to dryness, strained from the arsenious acid that deposits, diluted with water, and a current of sulphuretted hydrogen passed through the solution till the

sulphides of arsenic, copper, bismuth, and tin, are thoroughly precipitated. The filtered liquid is now boiled to expel excess of sulphuretted hydrogen, a little nitric acid introduced to peroxidise iron, and carbonate of soda added till the oxide of iron and carbonates of nickel and cobalt are all precipitated. The precipitate is now, after washing, digested in strong solution of oxalic acid and again well washed on a filter; in this way the soluble oxalate of iron is entirely removed. The oxalates of nickel and cobalt are finally dissolved in strong solution of ammonia, and the liquid exposed for several days, when the oxalate of nickel is deposited, oxalate of cobalt remains in solution, and on evaporating to dryness and heating in an open crucible, the pure oxides of cobalt are obtained.

Another process consists in adding one part of roasted cobalt ore by small portions at a time, to three parts of fused bisulphate of potash, and then increasing the heat till no more fumes are given off; in this way excess of bisulphate of potash is converted into neutral sulphate, sulphate of nickel is decomposed and arseniate of iron formed; the latter remains undissolved when the cooled broken up mass is digested in water. From the aqueous solution antimony, bismuth, or copper are precipitated by sulphuretted hydrogen and pure basic carbonate of cobalt precipitated by carbonate of potash.

Pure protoxide of cobalt may be obtained by washing, drying, and igniting the carbonate, or from the mixed oxides produced in the first process by solution in boiling hydrochloric, precipitation by carbonate of potash and reduction of the carbonate by heat as just described. It is an ash-gray powder that in contact with air gradually absorbs oxygen, becomes brown, and ultimately black: heat causes the same change but more rapidly.

Hydrated oxide of cobalt (CoO, HO) is a rose-coloured precipitate, formed when either of the fixed alkalies are added to a solution of a salt of cobalt: when first formed it is pale blue (a subsalt). It is soluble in ammonia and most ammoniacal salts.

Salts of the protoxide of cobalt are formed by dissolving the basic carbonate, already described, in acids.

Sulphate of cobalt (CoO, SO_3 + 7 aq.) crystallises from a solution, concentrated by evaporation, in carmine-coloured oblique rhombic prisms.

Nitrate of cobalt (CoO, NO_5 + 6 aq.) forms red deliquescent crystals. A solution of this is used in blowpipe operations. A small quantity of the substance under examination is moistened with the solution, and heated in the blowpipe flame in any convenient manner; a pink-coloured mass indicates the presence of magnesia; a green residue, zinc; and a blue, alumina.

Phosphate of cobalt (3 CoO, PO_5) is precipitated in violet flakes when ordinary tribasic phosphate of soda is added to a soluble cobalt salt.

Carbonate of cobalt (CoO, CO_2) is formed by digesting the basic carbonate 3 (CoO, HO) + 2 (CoO, CO_2), described under oxide of cobalt, in an alkaline bicarbonate.

Chloride of cobalt (Co Cl) is obtained in ruby-red octohedra, when a solution of the carbonate of cobalt in hydrochloric acid is evaporated. It does not deliquesce.

Sulphide of cobalt (CoS) is precipitated when sulphide of ammonium is added to a solution of a salt of cobalt. Two other sulphides also exist, *sesquisulphide* (Co_2S_3), and *bisulphide* (CoS_2), but they are comparatively unimportant.

Sesquioxide of cobalt (Co_2O_3) is a brownish black powder, formed on passing chlorine gas through a dilute solution of potash in which oxide of cobalt is suspended; or by adding solution of chloride of lime to moist hydrate of cobalt.

Salts of sesquioxide have not been obtained in a definite state.

Ammoniacal compounds of cobalt. According to M. Fremy, when an ammoniacal solution of oxide of cobalt is exposed to the air that the protoxide may, by absorbing oxygen, be converted into the sesquioxide, there are formed combinations of four, five, or six equivalents of ammonia with one equivalent of sesquioxide of cobalt. These bodies combine with acids to form salts, in which the power of the ammonia for saturating acids is not exerted in the slightest. On account of the difference in colour of their salts he has named the bases—

Fuscobaltia	Co_2O_3, $4NH_3$ (brown)
Roseocobaltia	Co_2O_3, $5NH_3$ (red)
Luteocobaltia	Co_2O_3, $6NH_3$ (yellow)

Claudet's ammoniacal salt of nitrate of cobalt (Co_2O_3, $5NH_3$)$3NO_5$ is an example of a salt of roseocobaltia. For further information regarding these interesting compounds, see a paper by M. Fremy, in 'Ann. de Chimie,' III., xxxv. 257.

Thénard's blue is a pigment that owes its delicate pale blue colour to cobalt. It is prepared by adding phosphate of potash to nitrate of cobalt, and mixing the resulting precipitate with gelatinous alumina obtained from carbonate of soda and solution of alum; the whole is finally evaporated to dryness and exposed to a dull red heat.

Rinman's green is produced by adding carbonate of soda to mixed solutions of the sulphates of cobalt and zinc.

Sympathetic ink. A dilute solution of chloride of cobalt has such a pale pink tint that characters written on paper with it are, when dry, invisible. On gently heating, however, the anhydrous chloride is formed, and this has a sufficiently deep blue colour to render the writing perfectly legible. On exposure to air, the paper absorbs moisture, and the figures or characters again become invisible. By mixing the cobalt solution with a small quantity of a zinc salt, letters, &c., may be described, that when heated appear of a red colour; or with a persalt of iron, a green colour; with copper, yellow.

The use of oxide of cobalt in the manufacture of porcelain, &c., has already been referred to. It is, however, well known, that from the difficulty of thoroughly disseminating the oxide, spots of a colour darker than the surrounding parts are apt to be formed. To obviate this, M. Carré, of Sèvres, recommends the substitution of oxide of cobalt by a solution of one of the salts of cobalt; the latter can be more easily mixed with the porcelain mass, or with greater facility applied to any desired portions.

A *test for cobalt*, in addition to the precipitation of the sulphide, oxide, carbonate, and phosphate, already described, consists in heating a fragment of the suspected substance with borax, supported on platinum wire in the blowpipe flame; if cobalt is present, the resulting bead has an intense blue colour.

Quantitative analysis of cobalt. Cobalt is always estimated in the metallic state. The oxide is first obtained by taking advantage of any of the processes already mentioned, and is then reduced in a current of dry hydrogen with the aid of heat, and finally weighed.

COBALT ORES. Cobalt is not found in the native state, and its ores, though not numerous, require a more minute examination than they have hitherto received. We shall notice those which are best known.

Bright white cobalt, or *white cobalt*, occurs crystalline and massive; the primary form is a cube, the planes of which are usually striated; colour silver-white; streak grayish-black; lustre metallic; hardness 5·5, yielding with difficulty to the knife, and not very frangible; specific gravity 6·3–6·5; fracture uneven; cleavage parallel to the faces of the cube; before the blowpipe on charcoal gives arsenical fumes; and tinges borax of a deep blue.

It is found in fine crystals at Tunaberg in Sweden, in Norway, Silesia, and Cornwall.

It is met with also amorphous, arborescent, botryoidal, and stalactitic.

Analysis of the crystals from Tunabuerg by

	Klaproth.	Stromeyer.
Cobalt	44	36·7
Arsenic	55	49·0
Sulphur	00·5	5·6
		6·5
	99·5	97·8

Tin-white cobalt, or *hard white cobalt*, occurs massive and crystallised in cubes and octohedrons; colour tin-white, but sometimes externally tarnished; fracture fine-grained and uneven; lustre metallic; it yields with difficulty to the knife, and is hard and brittle; specific gravity variously stated, from 6·74 to 7·7; yields arsenical vapour when heated with the blowpipe, and tinges borax deep blue.

The massive is amorphous, arborescent, botryoidal, &c. The amorphous occurs in Cornwall, and the crystallised at Skutterud in Norway. Analysis of the crystals by Stromeyer:—

Cobalt	33·10
Arsenic	43·46
Iron	3·23
Sulphur	20·00
	99·79

Gray cobalt occurs massive and crystallised; primary form a cube; colour grayish tin-white; streak grayish black; lustre metallic; hardness 5·5; specific gravity 6·466; fracture uneven; cleavage indistinct.

The massive occurs amorphous and reticulated. It is found principally at Schneeberg in Saxony, and is used in the manufacture of smalt.

Earthy cobalt occurs massive, amorphous, botryoidal, pulverulent, &c.; colour yellowish-brown and bluish-black; specific gravity 2—2·4; the fracture of the massive is earthy and dull, but polished by friction, and yields to the knife readily; when heated on charcoal gives an arsenical odour, and a deep-blue colour with borax. It is found in Hesse, Saxony, Bohemia, and also in Cheshire and Cornwall.

Sulphide of cobalt occurs yellowish-white and steel-gray; streak gray; it is amorphous or botryoidal, and externally brilliant; fracture uneven. According to Hisinger it consists of

Cobalt	43·2
Copper	14·4
Iron	3·53
Sulphur	38·50
Earthy matter	·33
	99·96

Arseniate of cobalt — Cobalt bloom — Red cobalt — occurs fibrous, massive, and crystallised; primary form an oblique rhombic prism; colour various shades of red passing into crimson; sometimes grayish; translucent, transparent; it is soft, light, and flexible; specific gravity 2·948; the massive variety amorphous, botryoidal: structure fibrous,

radiating; before the blowpipe emits arsenical odours, and tinges borax blue: it occurs in Saxony, Bohemia, Scotland, Cornwall, &c.

Analysis by Bucholz:—

Arsenic acid	37·9
Oxide of cobalt	39·2
Water	22·9
	100

Sulphate of cobalt—Red vitriol—is of a pale rose-red colour, and occurs investing other minerals, in small masses and in stalactites; the masses are semi-transparent and crystalline; it is soluble in water, translucent; lustre vitreous, often dull externally. It occurs among the mining heaps near Hanau and in Salzburg.

COBALTICYANIDES. [CYANOGEN.]

COBALTOHYDROCYANIC ACID. [CYANOGEN.]

COCCINONIC ACID. An acid of unknown composition, formed by heating euxanthic acid with nitric acid. Its salts of the alkalies are scarlet.

COCCOGNIDIC ACID. An acid of unknown composition, said to exist in the seeds of the *Daphne Gnidium*.

COCCULIN. [PICROTOXIN.]

COCCULUS, a genus of menispermaceous plants, for the botanical descriptions of which see NAT. HIST. DIV., comprises among others the *Cocculus palmatus*, of which the root furnishes calumba, a tonic of considerable medical efficacy.

Calumba acts chiefly upon the mucous membrane of the stomach, and upon the secretion and quality of the bile. It is not however without power over the nervous system, as its efficacy in allaying the vomiting of pregnancy testifies. In diarrhœa, after proper evacuants, and in bilious vomiting, it is superior to all other medicines. The vomiting and nausea of the early months of pregnancy are much alleviated by it; while the want of appetite, accompanied with general debility, of feeble children, is often removed by calumba along with preparations of iron.

Dr. Percival states that infusion of calumba will remove the disagreeable odour of putrefying ox-gall. Calumba-root, consisting as it does of one-third starch, should be given chiefly in the form of infusion or of tincture. For the preparation of the former *cold* water alone should be used, as enjoined by the Edinburgh Pharmacopœia; this leaves the starch undissolved, and extracts only the valuable active principles. The infusion made with boiling water spoils more rapidly than probably any other vegetable infusion; muddiness, followed by mouldiness, taking place very soon, especially if the infusion be allowed to stand on the dregs. Such a fermentable fluid cannot be a proper thing to introduce into an irritable or weak stomach, for which calumba is best suited of all vegetable tonics. Infusion of calumba made with cold water, combined at the moment of using with seltzer-water, is an excellent means of quieting the stomach at the beginning of fevers or bilious attacks. This also restores the appetite frequently lost from over mental exertion, or in the dyspepsia of sedentary literary persons. The common effervescing mixture made with lemon-juice or citric acid and bicarbonate of potash may be substituted, but it is not so good as seltzer-water.

COCHENILLIN. [CARMINE.]

COCHINEAL. (French, *Cochenille;* German, *Koschenilje;* Dutch, *Conchenilje;* Italian, *Cocciniglia;* Spanish, *Cochinilla, Grana;* Portuguese, *Cochenilha;* Russia, *Konssenel.*) Referring to the NATURAL HISTORY Division for an account of the insect, we will here simply say a few words concerning the trade in this valuable dye-stuff. Previous to the revolt of the Spanish American provinces almost all the trade in cochineal with the different markets of Europe was carried on through Spain, and chiefly through Cadiz; but since that event, and the consequent removal of the shackles which restricted the trade of Mexico, it has taken a more natural course, and the markets of consumption are supplied with cochineal either direct from the places of production, or from neighbouring stations, to which the article has found its way in the natural course of commerce. Representing a considerable value in a small bulk, cochineal is frequently used, with great convenience to merchants, as a medium for making remittances, and hence the comparatively circuitous route by which the greater part of it reaches the places of ultimate consumption. The quantity imported into Great Britain in 1827, was about 320,000 lbs.; which rose to 418,000 lbs. in 1835. So rapid was the increase in the next twenty years, that the importation in 1856 amounted to 2,000,000 lbs.; and in 1857, to 2,500,000 lbs. About one-half the quantity is brought from Honduras. Much is re-exported from England; but the increase of the trade is mainly due to the extension of dyeing, calico-printing, and colour-making in England.

COCK, or STOP-COCK, a kind of valve contrived for the purpose of permitting or arresting at pleasure the flow of a liquid through a pipe. The contrivances adopted for this purpose are very various; but those in most common use consist of a short tube of brass, intersected by a nearly cylindrical plug, capable of being turned on its axis, and so perforated or cut, that, while in one position it completely prevents the passage of fluid through the pipe, it may be so turned as to permit the fluid to pass through it, and consequently to flow through the pipe as though there was no plug to intercept its progress. In addition to the differences in the construction of the plug or valve itself, many varieties are required in the form and arrangement of cocks, to meet the various circumstances under which they are applied. Those which, under the name of *taps*, are employed for drawing off the contents of barrels, simply need to be driven into the holes provided for them, which, before the barrels are broached, are filled with corks to prevent the escape of their contents. This kind of cock, which has been selected for illustration in the following figures, usually terminates in a curved *nose*, or spout, from which the liquor may be conveniently received in a jug or other open vessel; but where it is desired to transfer the liquor from the cask immediately to bottles, the nose is prolonged into a long slender tube, which will enter the neck of a bottle, and obviate the necessity for a funnel. Other kinds of taps are adapted for insertion in metallic cisterns or boilers, or for soldering to the ends of leaden pipes. *Fig.* 1 represents, in section,

Fig. 1.

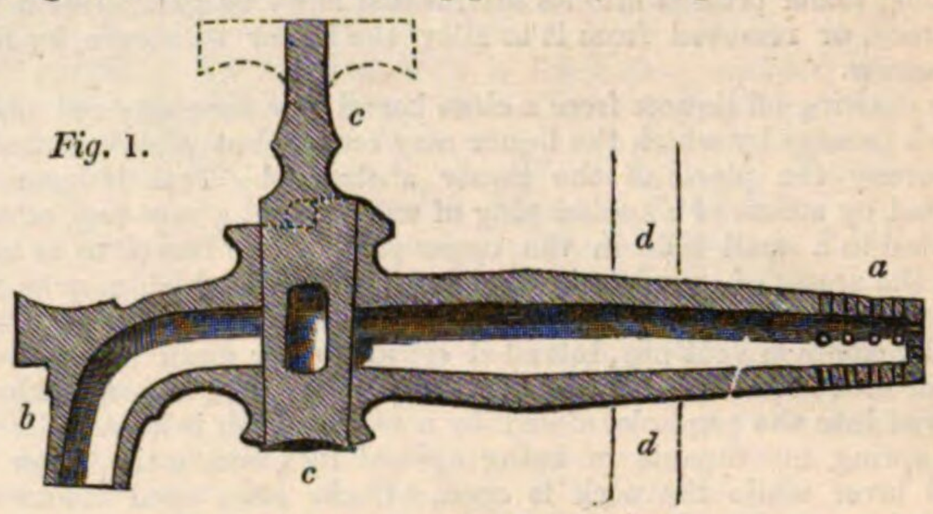


Fig. 2.

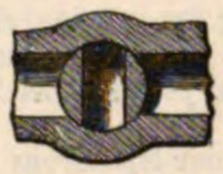
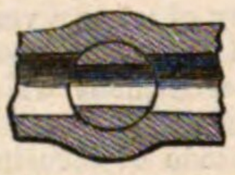


Fig. 3.



one of the most common kinds of cock or tap, constructed for insertion in a barrel, as represented by the dotted lines at *d*; *a* is the end driven into the barrel, and perforated with a number of small holes, through which the surrounding liquor passes into the interior of the cock, but which, by their minute size, prevent the entrance of foreign bodies which may be floating in it; *b* is the nose or spout through which, when the cock is opened, the liquor runs out into the vessel placed to receive it; *c c* is a nearly cylindrical plug, rather smaller at the lower than at the upper end, accurately turned, and ground into the opening formed through the cock to receive it, and having a vertical slit or passage formed transversely through its axis, which may, according to the position of the plug, either coincide with or be made to lie across and be totally disconnected from the tubular passage through the cock. This point is more fully explained by *Figs.* 2 and 3, which represent horizontal sections of the plug and its socket or barrel, *Fig.* 2 showing the plug in the position represented in *Fig.* 1, in which position it completely intercepts or closes the passage through the cock, and *Fig.* 3, the plug turned one quarter round, so as to cause its passage to coincide with that of the tube of the cock.

One of the first improvements on this contrivance which claims notice is that of securing the plug in its place by means of a screw in its lower end, instead of by riveting; by which arrangement the plug may be readily withdrawn for the purpose of cleansing the cock. Of the many improved cocks in which the common form of the plug is departed from, that represented in *Fig.* 4 is highly ingenious. In this

Fig. 4.

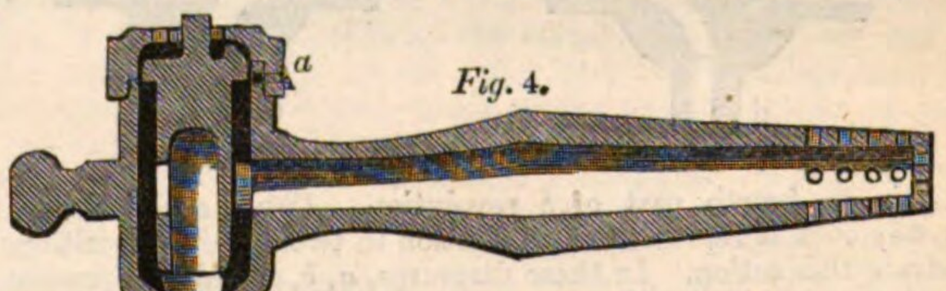


Fig. 5.

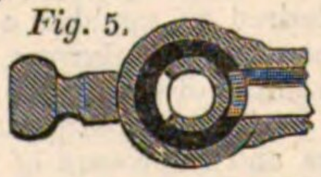
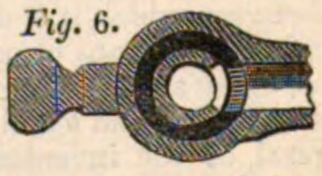


Fig. 6.



the horizontal tube or bore of the cock opens into a vertical cylindrical chamber or barrel which is lined with a hollow cylinder of cork, and within the cylinder of cork is another hollow cylinder of metal, which constitutes the moveable plug of the cock. Through one side of this hollow plug a circular hole is formed in such a way that in one position of the plug it will coincide with the horizontal passage of the cock, which is continued through the cork lining of the vertical chamber, and thereby allow the liquor to escape by the vertical nose or spout, while turning the plug half round the solid side of the plug is exposed to the passage of the cock, so as effectually to close it. Separate cuts are given to show the transverse section of the plug, *Fig.* 5 showing it in the same position as *Fig.* 4, so as to close the passage, and *Fig.* 6 representing it as turned round to open the passage. This cock is represented without the usual T-shaped handle, the top

of the plug being so formed as to be turned by a moveable key, which is inserted through a hole in the brass cap which is screwed on to the top of the vertical chamber of the cock.

In many cocks the principle of the revolving plug is altogether departed from. The simplest of these consists of a curved tube of which the end driven into the barrel is closed by a flat disc of metal, covered with a leather washer, which may either be drawn into close contact with the end of the pipe, or pushed back from it to allow the liquor to enter. A more complicated cock on this principle has the disc-valve applied to the lower end of a vertical pipe; but instead of working the valve by means of an internal rod, the screw of which must be exposed to the action of the liquor, has two screwed rods, outside the passage for the liquor, which are moved simultaneously by the application of a key of the ordinary kind. Another kind of cock, of which there are several varieties, has a solid conical valve, capable of being either pressed into its seat, which must be ground with great accuracy, or removed from it to allow the liquor to escape, by means of a screw.

In drawing off liquors from a close barrel it is necessary not only to open a passage by which the liquor may escape, but also to admit air to occupy the place of the liquor abstracted. This is commonly effected by means of a conical plug of wood called a vent-peg, which is inserted in a small hole in the upper part of the barrel, so as to prevent the access of air when it is not required, but which may be taken out while the liquor is being drawn off. A very convenient substitute for the common vent-peg, intended especially for small beer-barrels, is manufactured in brass. It consists of a small tube of brass, which is screwed into the peg-hole, closed by a valve which is kept in its place by a spring, but capable of being opened by pressing the finger on a small lever while the cock is open. Cocks have been contrived to avoid the necessity of using a vent-peg, by causing an entrance for air to be opened by the action of opening the cock; this is the meaning of the familiar advertisement "No vent-peg required," in reference to certain ale-barrels.

The common mode of securing liquor-taps from improper opening by the use of a moveable key in lieu of the fixed T-shaped handle, is very imperfect, owing to the facility with which a key of the kind usually employed is imitated, and the comparative ease with which the plug may be turned round without a key. This has led to many ingenious modes of locking the taps, but most of them are too expensive to be brought into ordinary use.

Some of the superior kinds of cocks are manufactured in fine brass, and others, intended for use with vinegar or other corrosive liquors, of a white alloy less liable to be injured by acids; but the greater part are formed of a peculiar alloy known by the name of *tap-metal*, made of brass and lead. Cocks are cast in moulds, with a core, the plug and the barrel being formed separately, and the vertical perforation in which the plug works is afterwards turned smooth by means of a quadrangular steel rinder. Cocks have been made of cast-iron, of porcelain, and of other materials. The *four-way cock* is an ingenious contrivance: it consists of a plug perforated with two distinct passages, and mounted in a barrel into which four separate pipes or channels open; and its object is to connect the four passages with each other in alternate couples, either by a continuous revolution upon its axis, or by an alternating motion

Fig. 7.

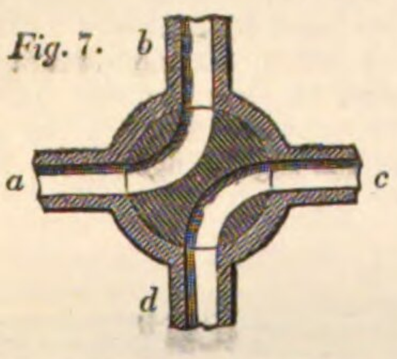
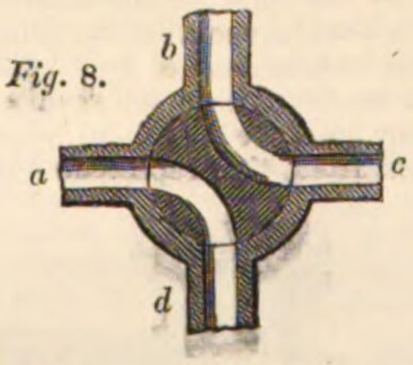


Fig. 8.



through one-fourth part of a revolution. *Figs.* 7 and 8, in which a four-way cock is represented in section in two different positions, will illustrate this action. In these diagrams, *a*, *b*, *c*, and *d* represent four pipes between which it is desired to establish a communication which shall afford the means of connecting at pleasure the pipes *a* and *b*, and *c* and *d*, or by a simple movement of the cock to disconnect these, and connect *a* and *d*, and *b* and *c*. This simple apparatus has been adopted by several of the inventors and improvers of the steam-engine, as a means of alternately admitting steam to and allowing it to escape from each end of the engine-cylinder. It has, however, been in great measure superseded by the slide-valve, in all the better kinds of steam-engines.

CODE, CODEX. Before the use of more convenient materials, wooden tablets were employed by the ancients for writing on. Such a written tablet was called codex, of which codicillus is a diminutive. (Seneca, 'De Brevit. Vitæ,' c. xiii.) First they wrote by making notches or indents in these tablets, but afterwards they covered them with wax, and used a style to write with. (T. Astle, 'On the Origin and Progress of Writing,' c. viii.)

The word codex itself, which is the same as caudex, originally signified the body or trunk of a tree; afterwards, by an extended use, it was applied to a collection of planks or beams forming a raft (Aulus Gell. lib. x. c. 15); and then, by way of analogy, it came to mean a book or collection of tablets, or sheets of writing on skins of parchment. (D. 32, 52, pr.) Of its general significations, then, the following may be noticed:—1. It may denote any handwriting on parchment or paper. 2. The diminutive codicilli, in the plural, besides meaning small tablets of wax, memorandum books, letters, and diplomas, also stands in the law books for codicil to a will, or less solemn additions to a testament. [Codicillus.] 3. A collection of laws is also called codex, or code in modern languages, as in English and French. In this sense the word is now most commonly used. There are several kinds of codes. A code may be made by merely collecting and arranging in a chronological or systematical order the existing laws of a state, which have been made at various times by the sovereign power. Such a collection is either made by public authority, as was the case with the Codex Theodosianus [Theodosian Code] and Codex Justinianus [Justinian Code and Roman Law], or by private individuals, as is the case with the Codex Gregorianus and Hermogenianus. The Germans call collections of old German laws, made in the middle ages, "Rechts bücher" (books of rights). Very different from a mere compilation of existing laws is a code (in German *Gesetzbuch*, book of laws), by which the legislative power sets up a new system of laws. A mere arrangement and classification of existing laws is more properly called a Digest; if to this classification and arrangement selection be superadded, it would still be properly only a digest. That some such notion as this influenced Justinian in the choice of titles by which he distinguished his celebrated collections of laws and constitutions may be gathered from the words of the code. (See C. 1., 17, 3, 1.) A code, though it may adopt many existing laws and customs, is now generally used to express a complete new system, founded on new fundamental principles; such principles, for instance, as are set forth in Bentham's 'Leading Principles of a Constitutional Code for any State.' In England, for example, if it were proposed to make a code, it might be found useful or necessary to modify the law of tenures, or to abolish certain kinds of tenures, such as customary tenures; and also to provide positive rules for numerous cases that are still either totally unprovided for or left doubtful by conflicting decisions, or regarded as of little authority. (See 'Humphreys on Real Property,' part ii.)

CODEIA. [Opium, Alkaloids of.]

CODEINE. [Opium, Alkaloids of.]

CODELA, an alkali existing in Opium.

CODES, LES CINQ, is the name given to several compilations of laws, civil and criminal, made in France after the Revolution, and under Bonaparte's administration. They consist of the Code Civil, Code de Procédure Civile, Code de Commerce, Code d'Instruction Criminelle, and Code Pénal. To these has been added the Code Forestier, or regulations concerning the woods and forests, promulgated under Charles X. in 1827. Hence the whole collection is sometimes called "Les Six Codes." But even this number is not correct, as there are also a Code de la Conscription, and a Code Militaire, both published under Napoleon. These two last are treated under Conscription and Mutiny Act.

Civil Code.—Before the year 1789 France possessed no general code or body of laws recognised as authority throughout all parts of the country; for the ordonnances of the kings, like the old Roman constitutions, although published for the benefit of the whole kingdom, and obligatory throughout it from one end to the other, yet neither laid claim to the dignity of codes, nor were intended to supersede the ancient laws. Two rival systems of law divided the country: one, that of the old customary law, embracing the provinces in the North; the other, that of the Roman or written law, embracing the provinces in the South. Such a division as this, and such a separation of interests, were in themselves evils of no little magnitude; but when, in process of time, the number of different and opposing customs became very materially increased, another evil was added to that of conflicting laws and legal principles; namely, a natural and almost insurmountable obstacle to a national union. To remove this was the aim of more French kings than one, foremost of whom must be mentioned Louis XI., whose efforts at establishing a uniform system of laws were only stopped by his death. In Henry III.'s reign, the publication of a code known by the title of 'Basilique,' and drawn up under the superintendence of the celebrated Brisson, was interrupted by the dagger of the assassin Clément; whilst the reigns of Louis XIII. and Louis XIV. were distinguished,—the first by the appearance of the Code Michaud in 1629, which shared the fate of its compiler, Michel de Marillac; the second by the publication of no less than ten ordonnances, passed either for the express purpose of codifying the several portions of the existing French laws, or with the view of removing obsolete laws and obstructive customs. (See the 'Collection des Ordonnances du Louvre,' published in 15 volumes between 1723 and 1840.)

But however eager in the cause of law reform, and however anxious for the codification of the laws, had these sovereigns been, it was not till the throne was overturned and the republic established on the ruins of the monarchy that the great task of forming a French code was commenced. The first step towards realising this dream of former rulers and legislators was taken in the year 1790, by the declaration announced in the 19th article of the 2nd title of the law on the subject of judicial organisation,—"A general code shall be formed, consisting of laws simple, clear, and appropriate to the constitution;" but the fury of

the internal factions, the cares of foreign war, and the frequent changes of rulers, prevented any calm deliberation on the subject during the first years of the revolution. After Bonaparte became first consul, he appointed, in 1800, a commission, consisting of Tronchet, president of the Court of Cassation, Bigot de Préameneu, Portalis, and Malleville, to draw up a project of a civil code. The project was printed early in 1801, and copies were sent to the Court of Cassation and the Courts of Appeal for their observations and suggestions.

These observations and suggestions were likewise printed, and the whole was then laid before the section of legislation of the council of state, consisting of Boulay, Berlier, Emmery, Portalis, Roederer, Real, and Thibaudeau. Bonaparte himself, and Cambacérès, one of his colleagues in the consulship, took an active part in the debates. The various heads of the code were successively discussed in the presence of the members of the commission, after which they were laid before the tribunate, where some of the provisions met with considerable opposition. The code, however, passed at length both the tribunate and the legislative body, and was promulgated in 1804 as the civil law of France, "Code Civil des Français." Under the Empire its name was changed into that of Code Napoléon, by which it is still often designated, though it has now officially resumed its original title of Code Civil. This code affects to define the civil rights of Frenchmen, and their legal relations to each other, and to society at large. In its general arrangement and distribution it resembles the institutions of Justinian; like them, it has adopted the great distinction of laws concerning the person, and laws concerning property. It consists of a preliminary title or introduction on the subject of the publication, the effects and the application of laws in general; and of three books, divided into titles or heads, each of which is subdivided into chapters and sections. Book I., in eleven heads, treats of persons; specifies their civil rights; regulates the means by which their rights are certified; prescribes the mode of registering births, marriages, and deaths; defines the conditions constituting the legal domicile of each individual; and provides for cases of absence. It then treats of marriage as a civil contract, the forms required, the obligations resulting from it, and lastly, of separation and divorce. The articles concerning divorce, which gave rise to much debate and opposition at the time, have been repealed since the Restoration, by the law of the 8th of May, 1816, and separation alone is now allowed; but with respect to the articles comprised in the 6th title on the subject of divorce, the editors of 'Les Codes Français annotées, 1850,' say that although undoubtedly divorce was abolished by the above law of 1816, yet from the want of any explanation accompanying that abolition, the result has been to introduce such disorder into this part of the Code, that it is very difficult to determine in any precise and satisfactory way what articles of this 6th title were intended to be preserved, and what have been actually destroyed; hence, as they point out, one consequence has been to enlarge the jurisdiction of the bench in these matters, to give the judges greater latitude in doubtful questions on this branch of the French law; and, it may be added, to inflict no little injury upon the system of codification by substituting for the *litera scripta* of the Code, the uncertain and varying opinions of the judge. The code proceeds to treat of the relations of father and son, of legitimate and natural children, of adoption and guardianship, and of paternal power. Under this last head the French code, without adopting the rigid principle of the old Roman law in its full extent, gives to a father the right of imprisoning his son, if he be less than 16 years of age, for a term not exceeding one month; but if he have attained the age of 16, then, between that time and the commencement of majority or emancipation, for a term not exceeding six months, by a petition to that effect, addressed to the president of the local court, who, after consulting with the king's attorney, may give the order of arrest without any other judicial forms being required; and may in the first case abridge the time of confinement required by the father. The remaining heads treat of minority, guardianship, and emancipation; majority, which is fixed for both sexes, at 21 years complete; of interdiction, and the council of trustees, called "judicial" advisers, appointed in certain cases to administer the property of a man who is incapable of doing it himself. Book II. treats of property and its various kinds and modifications. The 1st head draws the distinction between *meubles* and *immeubles*, or personal and real property; though these two words do not express, to an English lawyer, the distinction between *meubles* and *immeubles*. The 2nd defines the different rights of ownership. The 3rd treats of usufruct, use, and habitation. The 4th concerns rural servitudes, the *prædiorum servitutes* of the Roman law, excluding all former personal servitudes which were abrogated at the revolution. Book III. treats of the various modes by which property is legally acquired, such as inheritance, donation *inter vivos*, and wills or testaments. A father can dispose by testament of one-half of his property if he has but one legitimate child, of one-third only if he has two, and of one-fourth if he has three or more. The law then proceeds to treat of contracts or conventional obligations, specifying the modes of proving them by written documents, official or private, or by witness, or lastly by presumption; and after briefly explaining the subject of engagements arising without contract, it proceeds to the 5th head, which treats of the marriage contract, and the respective rights of husband and wife according to the various stipulations, either by community or separation of property, or by dowry. Next come the heads

of sales, exchanges, contracts of hire, partnerships, loans, deposits, and sequestration. The 12th head concerns aleatory contracts (including insurance, bottomry, loans, plays and wagers, and annuity contracts). The 13th, 14th, 15th, 16th, and 17th heads, treat of mandate, or procurations, suretyship, transactions, arrest of body and security, &c. The law treats next of power of attorney, of bail and security, and of amicable compromise. The 18th head concerns privileged creditors and mortgages. This subject is very elaborately treated, and has been much extolled as a very valuable part of the Civil Code, on account of the security which it gives to property by means of the public offices for registering mortgages, of which there is one in every district. The registration of mortgages has been adopted in most of the Italian states, and other countries besides France; but even this system is not considered perfect, because there is no obligation to register every sale or transmission of property, nor the servitudes affecting property, and because the French code admits of sales by private contract, and of mortgages in favour of minors or wives, even without registration. In this particular the Austrian code is considered superior, because it enforces the registration of every transmission of property, and of every burthen or servitude, on the book of census, or cadasto, for each district. Monsieur Anthoine de St. Joseph, in his very valuable work, 'Concordance entre les Codes Civil étrangers et Code Napoléon,' has extracted from Dr. Schein's 'Treatise on Public Registers,' the Austrian regulations on the subject, from which it appears that the intention aimed at in the establishment of public registration in Austria, is, as is stated in the text, to enforce the registration of all proprietary rights over immoveables, for which purpose there are five classes of public registers: 1. The principal book, containing a full description of the property, the owner's name, its estimated value, its incumbrances, burdens, mortgages, &c. 2. The book of documents, that is, of those documents on which the owner's title rests. 3. The book of debts. 4. The book of receipts and acquittals. 5. The urbarium, or book comprising a detailed statement of all the charges to which the estate is liable, certified by the owner's signature. The reader is referred to the preface of St. Joseph's 'Treatise,' pp. 89, *et seq.*, and to the preface of Troplong's 'Droit Civil Expliqué,' vol. i. of 'Priviléges et Hypothèques,' for some very able and searching criticisms on this part of the French civil code. (See also Grenier, 'Traité des Hypothèques,' 1824: 'Introduction.') The 19th head of the French civil code treats of expropriation or seizing, or selling off by execution; and the 20th, or last, of prescription.

Much has been written on the merits and defects of this celebrated code. In order to judge of its value, we ought to read the reports of the discussions in the council of state by the most distinguished jurists of France. (Locré, 'Esprit du Code Napoléon tiré de la discussion,' 6 vols. 8vo, 1805; Malleville, 'Analyse raisonnée de la Discussion du Code Civil au Conseil d'Etat,' 4 vols. 8vo, 1807; and Lerminier, 'Introduction à l'histoire du Droit,' &c. c. 20.) On the other side, several distinguished German jurists have pointed out its imperfections. (Savigny, 'On the Aptitude of our Age for Legislation,' translated from the German by a barrister of Lincoln's Inn; Rehberg 'über den Code Napoleon,' Hanover, 1814; Thibaut, Schmidt, &c.) With regard to the part which Bonaparte took in its discussion, not of course as a professional man, but as a quick-sighted observer and critic, a lively account is given in Thibaudeau's Mémoires sur le Consulat,' in which his own original expressions are preserved. (See also Barrett, 'Translation of the Code Napoléon,' vol. i., p. ccclxxxviii. &c.; and Blaxland's 'Codex legum Anglicanarum,' pp. 173, *et seq.*, where a very good sketch appears of Cambacérès' three projects, that of the legislative commission, and Napoleon's commission for a Code.

Code de Procédure Civil.—The Code Civil having determined what was law, it remained to prescribe the forms of civil process and the practice and rules of the courts. The Code de Procédure is divided into two parts. The first part treats of the ordinary forms of procedure before the various tribunals, and contains five books, of which the 1st relates to justices of peace and their jurisdiction. There are about 2840 of these magistrates in France, who decide petty cases not exceeding 300 francs, and also act as conciliators between parties at variance, who are not allowed to plead before a court without having first appeared before the juge de paix. The 2nd, to the process before the tribunaux de première instance, which try civil cases without jury. There is one of these courts in every arrondissement. The 3rd, treats of appeals to the Cours Impériales, of which there are 27 established in the larger towns, each having several departments under its jurisdiction; these courts try cases by jury. The 4th, of various modes of attacking judgments. The 5th, of the execution of judgments. The second part treats, in three books, of the different forms of procedure in the several cases indicated; the 1st book discusses (*inter alia*) offers of payment on the debtor's part, and of 'consignation' or payments into court in satisfaction of a debt; separation between husband and wife; interdiction and cession of property by an insolvent debtor. Foreigners are excluded from the benefit of the *cessio bonorum*. The second passes to the subject of inheritance, the affixing of seals, taking inventories, &c. The last book treats of arbitration. The Code de Procédure was in great measure founded on, or rather is a modification of, the ordonnance of 1667 of Louis XIV., with considerable ameliorations. It was framed by a commission appointed in 1802, consisting of Treilhard, Try, Séguier, Berthereau, and Pigeau, then discussed in

the council of state and the tribunate, and lastly passed by the legislative body. It was put in force in January, 1807. "An orator of the government, using the licence of flattery, said in his report that the principal difficulties in definitively settling the code had been cleared up by the emperor himself, who had adapted the forms to the present wants of society. The fact is that Napoleon took no part in the discussion of this code, which was conducted during his journeys to Italy and to the camp of Boulogne, and during the campaign of Austerlitz. Besides, it was a dry and unattractive subject, very unlike that of the Civil Code, and the emperor finding himself a complete novice in it, gave it up entirely to professional lawyers. His general views would have been to simplify the forms, and to check the sources of chicanery, but he was not heeded. One of his ideas was that solicitors and counsellors should not be paid unless they gained the cause. The routine lawyers, however, had too much influence in the work." (Thibaudeau, 'Histoire de France sous Napoléon,' vol. v., pp. 124-5.) The government afterwards published a table of the expenses, duties, fees, &c., attending civil process. The table, which is given at the end of the collection of the codes, presents a formidable appearance by the multiplicity and minuteness of the charges which attend every step of legal proceedings. Indeed this is the principal reproach made against the Code de Procédure, the multiplicity of formalities, written acts, registrations, stamps, &c. Another objection is, that in actions in which the state is concerned, it has advantages over private parties. But the publicity of the discussions, the security to all civil proceedings by means of registration, the well-defined authority of the various courts, the independence of the judges, and the establishment of local courts all over the country, and above all the institution of the supreme Court of Cassation—these are essential and lasting advantages. For an excellent résumé and criticism of the Code de Procédure, the reader is referred to the 'Law Magazine, or Quarterly Review of Jurisprudence' (1829), p. 454, *et seq.*; and for a practical explanation of its different articles to 'Les Codes Français annotées' (Teulet, D'Anvilliers et Sulpicy), vol. 2.

The *Code de Commerce* was promulgated in January, 1808. Its principal elements were drawn from the two celebrated ordonnances of Louis XIV., for which France is indebted to the genius of Colbert; that of 1673 relating to land commerce, and that of 1680 to maritime. Next to the Civil Code, it is considered the best part of French legislation. The institution of the commercial tribunals has been of great advantage to France, and has been adopted in other countries. These courts, of which there are 213, consist of a president and two or more judges, all chosen by the merchants among themselves, and for a time; they are not paid, but the greffier or registrar receives a salary. The Code de Commerce consists of four books: the first treats of commerce in general, of the various descriptions of commercial men, of the keeping of books, of companies and partnerships, of brokers, commissioners, carriers, &c.; the second treats of maritime commerce, shipping, insurances, &c.; the third concerns bankruptcies; and the fourth treats of the commercial tribunals, their jurisdiction and proceedings. Appeals for cases above 1000 francs lie to the cour impériale of the district. As the subject of French mercantile law generally has no small claim on the attention of the civilised world, more especially on that of our own merchants and lawyers, a reference to some of the leading French authorities on the Code de Commerce may not be without its use; of these, the treatises of Pardessus and Boulay-Paty, on commercial law ('Cours du droit Commercial'), deserve the first place from the reputation of the authors, and the extent of the subject discussed in their pages. On the code itself M. Isidore Alauzet has published a commentary ('Commentaire du Code de Commerce'), in which each article is discussed and illustrated separately. M. Delangle has selected the third title of the 1st book, for a learned explanation of mercantile partnerships; whilst the well-known treatise of Mons. Locré, 'Esprit du Code de Commerce,' exhausts the subject as it was known to the public of 1811. Two English treatises of recent date ought not to be passed over, Mr. Leoni Levy's work on 'Commercial Law,' and a very useful little treatise called 'The Mercantile and Bankrupt Law of France,' by Henry Davies and Emile Laurent.

Code d'Instruction Criminelle.—The criminal laws of France under the old monarchy were defective, confused, and arbitrary. There was no penal code, but there were various ordonnances for the punishment of particular offences. The ordonnance of Louis XIV. for regulating proceedings in criminal cases, introduced something like uniformity, but it maintained torture, which in some cases was repeated, secret trial, and other anomalies of the legislation of the middle ages. Torture was abolished by Louis XVI. The first National Assembly in 1791 recast the criminal legislation, introduced the jury, and remodelled the criminal courts after those of England. Then came the reign of terror, with its exceptional laws, or rather no laws at all but the caprice of the ruling faction. Bonaparte, when first consul, appointed a commission, consisting of Viellard, Target, Oudard, Treilhard, and Blondel, to frame a project for a criminal code. The fundamental laws were laid down in 1801, and were then discussed in the council of state. Bonaparte took a lively part in these first discussions, especially on the question of the institution of the jury, which he strongly opposed on the ground of the probable incapacity or party spirit of jurors: he looked upon the question in a political rather than a judicial light. Portalis, Simeon, Bigot de Préameneu, and Ségur sided with Bonaparte.

Treilhard, Berlier, Defermon, Crétet, Bérenger, Merlin, and Louis Bonaparte defended the jury. There is an interesting account of this discussion in Thibaudeau (vol. vii. p. 88, &c.); and in 'L'Encyclopédie du droit' (1845), tom. iv. art. Codes Français, pp. 377-78. The question being put to the vote, the majority was favourable to the jury. The matter, however, was finally settled by suppressing the jury d'accusation, or grand jury, and retaining the jury de jugement. The jurors are taken from the electors who are qualified to vote for a member of the legislature, graduates in law, medicine, and other sciences, notaries, &c., and must be 30 years of age, and in the full enjoyment of all political and civil rights. A list of persons so qualified is made out by the prefect of the department, from which the President of the Cour Impériale, or of the Cour d'Assise, selects the number required to serve. The proceedings in criminal trials are partly written and partly oral. The accused is first brought before the procureur (attorney-general), who examines him and simply reports the case to the juge d'instruction, without giving any opinion upon it. At the same time, if the accused is charged with a crime punishable with personal and degrading penalties, he orders his detention. For mere délits or misdemeanours, bail is allowed. The juge d'instruction summons and examines the witnesses, and then sends back the report to the procureur, who makes his remarks on the case, which is then laid before the chambre de conseil, consisting of three judges of the tribunal de première instance. These judges investigate the case minutely, and decide if there is ground for further proceediugs. In such case the report is laid before the chambre d'accusation, composed of five judges of the Cour Impériale, who ultimately decide for commitment or acquittal. If committed for a crime punishable by peines afflictives or infamantes, the prisoner takes his trial before the next cour d'assise of the department. If for mere délit or misdemeanour, he is sent before the correctional tribunal. The courts of assize consist of a president and three judges, chosen from among the members of the Cour Impériale and of the tribunal de première instance, and their sessions are held every three months in the chief lieu of each department. The jury decide by a majority on the fact of the charge; eight constitute a majority. The court then awards the sentence, having a discretion between a maximum and a minimum penalty. By a law passed since 1830 the court can no longer reconsider the verdict of the jury, as was the case before. The prisoner, or his counsel for him, may challenge the jurors as they are called peremptorily, but as soon as all the list of jurors, save twelve, is gone through, the challenges, whether on the part of the accused or the prosecution, cease. One or two juges d'instruction are attached to each court of assize for criminal cases; they are generally taken from among the juges de première instance, and for a definite time only. The Code d'Instruction Criminelle consists of the following books: 1. Of the judiciary police and the various officers whose duty it is to inquire after offences, collect the evidence, and deliver the prisoners to the proper courts. These officers are very numerous, including the maires and their assistants, the commissaries of police, the rural guards and forest-keepers, the justices of the peace, the procureurs and their substitutes, the juges d'instruction, &c. It also treats of the manner of proceeding by the procureur as already stated, and of the juge d'instruction and his functions, distinguishing between cases of flagrant crime and others. Book 2 treats of the various courts; tribunaux de simple police, which take cognisance of petty offences, and can inflict imprisonment of not more than five days, and a fine not exceeding fifteen francs; tribunaux en matière correctionnelle, which are composed of at least three judges of the tribunaux de première instance, and take cognisance of délits or misdemeanours, the penalties for which are defined in the Code Pénal; cours d'assise, already mentioned, from which there is an appeal for informality or want of jurisdiction to the Court of Cassation; lastly, the cours spéciales or exceptional courts, which Napoleon insisted upon having at his disposal, and which have been resorted to repeatedly since the Restoration, and still appear on the code. These special courts are assembled in cases of armed rebellion against the authorities, but they also take cognisance of the offence of coining and of crimes committed by vagabonds and convicts who have escaped; they are composed of a president taken from among the judges of the Cour Impériale, four judges, and three military officers of the rank of captain or above. They try without jury, judge by majority and without appeal, and the sentence is executed within twenty-four hours. On the subject of the Code d'Instruction, Thibaudeau observes that it retained many of the ameliorations introduced by the National Assembly, especially the publicity of trial and the institution of the jury. Its chief faults are, the great number of officers, some of them merely administrative, who are charged with the pursuit of offenders, by which circumstance the citizens are often exposed to vexatious interference; the too great extent given to the jurisdiction of the correctional courts, by which, in many cases, the citizens are deprived of the guarantee afforded by the jury; the restrictions on the choice of jurors, which is too much in the power of prefects and other local authorities; the institution of the special courts; and, lastly, the frequent abuse of the power of the police, by which its agents could issue warrants of arrest.

"Prefects and commissary-generals of police often had individuals arrested, and left them in prison waiting for the decision of the minister of police, who answered at his leisure, or at times confirmed

the order of arrest for an indefinite time. And as by Art. 75 of the Consular Constitution of the year 8, any suit against the agents of government was forbidden without an authorisation from the council of state, there was in fact no redress against arbitrary acts." ('Hist. de France sous Napoléon,' vol. vii. pp. 124-9.)

This last abuse is now corrected, or at least greatly mitigated. Other provisions of the Code d'Instruction, as well as of the Penal Code, have been also altered for the better by the law of 28 April, 1832, entitled 'Modifications aux Codes d'Instruction Criminelle et Pénal,' which is found at the end of the later collections of the French codes.

The *Code Pénal*, or laws defining crimes and punishments, was completed in January, 1810. Its discussion occupied forty-one sittings of the council of state. Of these sittings Napoleon attended only one (21 January, 1809); Cambacérès presided at all the rest. "Napoleon was therefore a stranger to its discussions; he only expressed an opinion that the laws ought to be concise, and leave much latitude to the judges and the government in the application of the penalty, 'because,' said he, 'men had feelings of compassion unknown to the law.'" He insisted upon the penalty of confiscation being retained in certain cases, because most nations had sanctioned it in cases of conspiracy, rebellion, and false coining. "But the definition of crimes and offences, the nature of the penalties, and the mode of their application, were the work of criminal jurists, who were generally inclined to severity, and were well acquainted with the ideas of Napoleon, who was persuaded that criminal legislation ought to be very rigorous in order to maintain order and support the authority of the government." (Thibaudeau, vol. viii. p. 3.) Hence the penalty of death was fixed in numerous cases, and those of perpetual imprisonment, hard work, or transportation for life, in a still greater number. The pillory is also one of the punishments.

If we look at book iii. ch. 1, which treats of the crimes and offences against the safety of the state (a term susceptible of indefinite and arbitrary application), we find that the penalties of death and confiscation are fixed very generally. Confiscation however has been solemnly abolished by a law passed under Louis XVIII. By the head, "Des critiques, censures ou provocations contre l'autorité publique dans un discours pastoral," any clergyman found guilty of having, in a pastoral charge, sermon, or other public address, spoken or printed, criticised or censured any act of the government authorities, is subject to banishment, transportation, or even death, according to the consequences which have resulted from his act. The following head, "Résistance, désobéissance, et autres manquemens envers l'autorité publique," is equally severe. The article "Délits commis par la voie d'écrits, images ou gravures, distribués sans nom de l'auteur," &c., concerns the press, which was under a strict censorship in Napoleon's time. After the Restoration the censorship was abolished, and several laws were enacted to repress abuses of the press, especially in April and October, 1831. An important law on this subject was promulgated in September, 1835, consisting of five heads: 1. Crimes, délits et contraventions. 2. Du gérant (editor) des journaux ou écrits périodiques. 3. Des desseins, gravures, lithographies, et emblêmes. 4. Des théâtres, et pièces de théâtre. 5. De la poursuite et du jugement. It is printed at the end of a collection of codes, laws, &c., published in 1835, and styled 'Les dix-huit Codes du Royaume.' The last general law relating to the press was published on the 16th of February, 1852, which contains some very stringent provisions, by which, among other things, it is enacted that no journal or periodical relating to political subjects or *social economy* shall be started or published without the authorisation of the government; that no foreign journals on the same subjects shall circulate in France without the same authorisation; that all proprietors of such journals whose publication is allowed must deposit with the Treasury a certain sum in cash by way of caution money; and that for infringements of these rules the punishment shall be imprisonment varying from one month to a year, and a fine ranging from 100 fr. to 5000 fr. in each case. In addition to these regulations, a stamp duty is imposed upon all journals or periodical publications; punishments by imprisonment and fine are decreed for the publication of false news and fabricated documents. Unauthorised accounts of the sitting of the senate, and *all reports of* trials for press offences (which are merely *to be mentioned*) are interdicted; and all gérants, or managers of newspapers, are compelled to insert at the head of their journals any official documents, of whatsoever kind, that may be addressed to them by any public authority. The 32nd article specifies the regulations on the subject of the official condemnation of a journal for contraventions or offences of the press, one short extract from which will give the reader a specimen of the spirit of the whole law itself: "A journal may be suspended by ministerial decision even when it has not been the subject of any condemnation, after two formal notifications, and during a period which cannot exceed two months." By the section of the Penal Code entitled 'Des Associations ou Réunions illicites,' which continues in force to this day, every association of more than twenty persons for the purpose of meeting on fixed days to discuss either political, religious, literary, or other subjects, is declared illegal, unless it first obtain the approbation of the government, which can prescribe conditions and fix regulations at its pleasure. The chiefs or directors of any such illegal association are punished by fine. If at the meetings of such assemblies there has been any provocation to crimes or délits, as defined in the other articles of the penal code, the chiefs or directors and administrators are liable to imprisonment from three months to two years, besides fine, although they themselves may not have been guilty of the offence. No individual can lend his house or apartments for the meeting even of an authorised association, unless he first obtain the permission of the municipal authorities. By a law which passed the Chambers in April, 1834, the above regulations have been made even more strict. Every member of an illegal association is liable to a fine of 1000 francs, and to imprisonment from two months to one year. For the existing regulations on the subject, as comprised in the Code Pénal and the law of 1834, the reader is referred to the second volume of 'Les Codes Français Annotées' (edition 1850). Under the heads "Vagabondage" and "Mendicité," vagrants are defined to be all those who have no fixed domicile, nor means of subsistence, and who do not follow habitually any trade or profession. On the legal evidence of being such, they are condemned to an imprisonment of from three to six months, after which they are "at the disposal of government." With regard to mendicants or beggars, any person found begging in a place where there is a workhouse or depôt for the poor is subject to from three to six months' imprisonment. But the next article is much more liable to objection on the score of justice and humanity; it runs thus: In places and cantons where there is no depôt for the poor (which is the case in most rural districts of France), able-bodied beggars shall be imprisoned for a period of from one to three months; and if arrested out of the canton where they reside, they are imprisoned for a term of from six months to two years. By Article 402, bankrupts not fraudulent are liable to imprisonment from one month to two years. Brokers in the same situation are condemned to hard work for a time.

The law of France makes a wide distinction between native and foreign insolvents in two important points: first, in the preliminary proceedings of a suit, both as regards the person and the goods and chattels of the foreigner; and secondly, as regards the term of imprisonment. For, as respects the first of these points, "when a French subject claims a debt, no matter of what amount, of an alien, and produces in support of his claim written evidence, either of a nature held to be conclusive, or of a character to raise a strong presumption in favour of the claim, the French Tribunal *will, upon application, grant a warrant of apprehension* against the person of the alleged alien debtor, unless the latter has an establishment in France. The court will also, under the same circumstances, grant the claimant authority to seize and hold in pledge, for his protection, the goods and chattels of his alleged alien debtor." ('The Mercantile and Banking Law of France,' p. 2; Davies and Laurent.) While, with regard to the second, foreigners not domiciled in France, having no commercial establishment or real property there, are liable to double the period of imprisonment that a Frenchman is, namely, two years for a debt less than 500 francs; four years for a higher sum under 1000 francs; six under 3000; eight for less than 5000; and ten years for 5000 and upwards. (Okey, 'Concise Digest of the Law, Usage, and Custom affecting the Commercial and Civil Intercourse of the Subjects of Great Britain and France.') By the head 'Violations des réglemens rélatifs aux manufactures, au commerce, et aux arts,' any coalition between masters to lower wages is punished by a fine of from 200 to 3000 francs, besides imprisonment not exceeding a month. Coalition among workmen, followed by an attempt to stop the works of a manufactory, is punished by imprisonment of from one to three months; the leaders or originators of the coalition or attempt are subject to imprisonment from two to five years. By Article 417, any one who, with the view of injuring French industry, has removed to a foreign country the workmen or clerks of a manufactory, may be imprisoned from six months to two years, besides paying a fine of from 50 to 300 francs. Article 418: Any director, clerk, agent, or workman, of a manufactory, who communicates to foreigners or to Frenchmen residing abroad, any secret of the fabric in which he is employed, is punished by a fine of from 500 to 20,000 francs, besides imprisonment at the discretion of the court. Article 421: All wagers or bets upon the rise or fall of the public funds are punishable by imprisonment from one month to one year, besides a fine of from 500 to 10,000 francs. The offenders may, after the expiration of their imprisonment, be placed by sentence of the court under the surveillance of the haute police from two to five years. This sentence, "placed under the surveillance of the high or government police," which is added at the end of numerous penalties, means that the person so placed is to give security for his good conduct; in default of which he is "at the disposal of government," who may fix a particular place for his residence. All individuals who have undergone the punishment of hard work for a time, or that of banishment or transportation, or those who have suffered a penalty for political crimes, are placed, *de jure*, under the surveillance of the high police for the rest of their lives.

The above extracts are sufficient to show the spirit in which the French criminal code has been framed. It is, in fact, as harsh and illiberal in many of its enactments as that of any absolute government in Europe. In speaking, therefore, of Napoleon's legislation, it is necessary to discriminate between the civil and the criminal laws; and again between the laws themselves and the practice and rules of proceeding in the courts. The adoption of the French criminal code met

with great opposition in Italy. At Milan the legislative body attempted to modify and adapt it to the habits and wants of the Italians. Two commissions were appointed by the minister of justice, one for the Code d'Instruction and the other for the Code Pénal. Their reports were sent to Paris, but were rejected by Napoleon, and an answer came with peremptory orders to translate literally, and enforce the two French codes without any alteration. At Naples similar objections were also made, but with no better effect. (Colletta, 'Storia del Reame di Napoli,' book vi.)

For comments and strictures by French jurists on the criminal laws of France, see Bérenger, 'De la Justice Criminelle en France,' 1818; Dupin, 'Observations sur plusieurs points importans de notre Législation Criminelle;' and Bavoux, 'Leçons préliminaires sur le Code Pénal,' 1821; Bourgignon, 'Jurisprudence des Codes Criminels' (Préface), 1825; 'Encyclopédie du Droit' (1845), Art. 5, p. 374; and for a comparison of the French and English systems of criminal law, see Cotton, 'De l'Administration de la Justice Criminelle en Angleterre, et de l'esprit du Gouvernement Anglais.'

There are in France more than 3000 judges, including those of the commercial courts, besides 2840 juges de paix. The judges of the Tribunaux de Première Instance have salaries varying from 2000 to 6000 francs; those of the Cours Impériales, from 3000 to 8000. The presidents and vice-presidents receive more in proportion. The juges de paix receive about 800 francs, besides certain fees. The various courts, magistrates, greffiers, &c., cost the state about fifteen millions of francs annually. (Goldsmith, 'Statistics of France,' 1832.)

For a general view of the judiciary system of France, see Meyer, 'Esprit des Institutions Judiciaires,' last vol.; and Rey, 'Des Institutions Judiciaires de l'Angleterre comparées avec celles de France et de quelques autres Etats,' 1826.

CODICIL. [WILL.]

CODICILLUS, the diminutive of Codex, signifies properly a small trunk or stump of a tree (*parvus codex*), but in process of time the word had, like Codex itself, various meanings given it, more especially in the plural, when it came to signify little tablets smeared over with wax, and marked or written on with a stylus. To the constant use of these among the ancients before the discovery of paper or the application of the papyrus, Pliny bears witness in two passages of the 'Natural History,' in each of which he uses the word codicillus. ('Nat. Hist.,' l. 13, c. 13; and l. 33, c. 4.) But after the invention of another material for writing on, another meaning was given to the word codicilli, namely, that of memorandum, or note-book, in which entries were hastily jotted down for the purpose of being copied in extenso on charta or paper. (Cic. 'Philip' 8, c. last but one; 'Fam. Ep.,' l. 9, ep. ult.) Not that this was the sole meaning of the expression, for we find Cicero and Seneca using it in the sense of letters, especially those intended for neighbours and intimate friends. (Cic. 'Fam. Ep.' 6, 18; Seneca, 'Ep.' 55 *in fine*.) From this confined signification it was extended to that of a book, treatise, or writing (Tac. 'Ann.' 11, 34); to that of a memorial and petition (Tac. 'Ann.' 4, 39; 69); to that of a letter conferring privileges, in which sense it is found in the Cod. Theodos. tit. 4, l. 23; and lastly, as a technical legal term to that of letters addressed by a testator to the heir or heirs named in his will, as to certain things which the testator wished to be done by his heir or heirs after his decease. (Heinecc., 'Antiq.,' ii., tit. xxiii. and xxv., sect. xi.)

The difficulty which existed, out of Rome, of procuring the legal number of Roman citizens as witnesses to a solemn will, led to the use of codicils. The story of their invention and progress in the jurisprudence of Rome is told very graphically in the 'Institutes' (ii. 25), from which it appears that Lucius Lentulus, just before his death in Africa, had appended some codicillary memoranda to his will, addressed to Augustus, and in them had requested the emperor to do some act for him by way of a *fidei commissum*. These instructions were obeyed by the emperor, as well as by sundry other individuals who seem to have received similar requests, whereupon Lentulus's daughter, probably out of reverence for her father's memory, took upon herself to pay certain legacies, which could not have been legally obtained by the legatees. The emperor, it is then stated, influenced perhaps by the novelty no less than the advantages of this addition to the testamentary powers of a citizen, summoned the leading lawyers of the day, and on their authority, backed by that of Trebatius, gave his formal assent to the introduction of these codicilli. From that time codicils became legal instruments.

Codicilli have been defined to be supplements or additions to a testament, which are to be considered as annexed to the will itself, for the purpose of adding, explaining, or altering something in the previous disposition. But such a definition does not give an exact notion of the term; and, besides this, it applies only to the cases where the person making the codicil dies testate; consequently it does not take in those cases where no will exists. More correctly, codicil is defined to be a less solemn will, in which, as well as in a solemn will or testament, every disposition that can be effected by a last will may be made, except the appointment of direct heirs and exheredation; that is, the disinheriting of sons, daughters, &c. Codicils were commonly used for the purpose of naming bequests or legacies to be paid by the heirs already appointed by a testament, and for explaining and clearing up obscurities and want of precision in a testament.

There are two species of Roman codicils: *ab intestato*, when a man who made a codicil died intestate; and *codicili ad testamentum facti* when he died testate. In the former case the dispositions in the codicil had reference to the heres ab intestato, or the person to whom the law gave the intestate's property. Codicils of the second species were either confirmed by the testament (codicilli confirmati) or not (non confirmati). Before Justinian's time there were several differences between these two sorts of codicils, particularly as to legata and fidei commissa; but the different species of bequests being put on the same footing in the reign of Justinian, the distinctions ceased. In the time of Pliny the Younger, a codicil made before a subsequent will ought to be confirmed by the will (lib. ii., Ep. 16); but this was afterwards dispensed with. ('Instit.,' ii. 26.) Sometimes future codicils were confirmed by a prospective will.

Codicils might be written, in which case they were either public or private; or they might be verbal directions given to the heir. In their origin codicils had no particular forms, but the Emperor Constantine required witnesses to codicilli ab intestato, and to codicilli non confirmati; and Justinian required witnesses for all private codicilli.

A testament wanting the legal forms required for such a solemn instrument might be maintained as a codicil if the legal forms for a codicil were observed, and the will contained what is now termed codicil-clause (clausula codicillaris). (See Brissonius, 'De Formul.,' lib. viii.; Gaius, lib. ii. 270, Dig. 29, tit. 7; and McKeldey, 'Systema Juris Romani,' § 700–704.)

CODIFICATION. [LAW AND LEGISLATION.]

CO-EFFICIENT (in Algebra). When two or more numbers are multiplied together, each of them is called a factor of the product, and a co-efficient (or co-factor, as it were) of the other factors. Thus the factors of the product $a \times b \times c$ are a, b, and c; and a is the coefficient of $b \times c$, b of $a \times c$, and c of $a \times b$. But the word is most frequently used for that which should be distinguished as a numerical coefficient; thus in $2x \times 3y$, 2 and 3 are respectively the coefficients of x and y. This word is as old at least as the writings of Vieta, in which it has its present sense.

When there is a multiplier depending upon the result of experiment connected with any particular property of matter, the number is frequently called the coefficient of that property. Thus by the co-efficient of friction for any substance, is meant the fraction of the pressure which is equivalent to the friction of that substance.

COEHORN, a small mortar for throwing grenades, invented by the engineer of that name.

COEMPTUS. [MARRIAGE.]

CŒNOBITES. [CONVENT.]

COFFEE—*Medical uses of.* The action of coffee on the human system is due chiefly to the empyreumatic oil, and consequently is greatest when roasted; but its extractive and also highly nitrogenous principle, *caffeina*, must exert considerable influence upon the organs of digestion.

Coffee acts powerfully and peculiarly on the ganglionic system of nerves and their ramifications, and all the organs which are supplied by them. It elevates the vitality of these nerves, and quickens all their actions. The brain is likewise markedly acted upon by it; and hence the increased sensibility and greater energy of that organ during the use of coffee, and the removal of all sense of fatigue or disposition to sleep. Upon this depends, in addition to its local influence upon the organs of digestion, the utility of coffee in counteracting the effects of narcotic poisons, such as opium or belladonna, and the favour it has found among literary persons from enabling them to carry on their studies through the midnight hour without feeling oppressed by sleepiness. It greatly promotes digestion if taken after dinner, and also checks the disturbance of the nervous system arising from the too free use of wine. It excites the vascular system, and renders more powerful the contractions of all the muscles, both voluntary and involuntary. It fits the system therefore to resist the influences of cold and damp, and is proper for night travellers and the inhabitants of humid climates, such as Holland. In warm climates it removes the languor which oppresses those who are exposed to the excessive heat, and helps the stomach to perform its office.

It is not without its counterbalancing disadvantages. For plethoric persons, and those who have a tendency to abdominal congestions, it is unsuited; and for persons subject to piles it is in general improper, as well as for females under certain states of their system. It is likewise hurtful to persons having a very excitable vascular system, being upon the whole more suitable for slender persons or those advanced in life, than for the young or very robust.

Coffee, like all stimulants, when used to an injurious extent, gives rise to disturbances of the nervous system, particularly painful twitchings of the upper eye-lid, to congestion or hæmorrhages, loss of digesting power, and obstruction of the liver and *vena porta*. Unlike the nervous symptoms caused by tea, the greatest number of these complaints subside or disappear on discontinuing the use of the strong beverage.

Coffee is much more extensively used as an article of diet than of medicine. Raw coffee, either in the form of powder or of infusion, has been found very serviceable in the cure of intermittent fevers. ('Edinburgh Medical and Surgical Journal,' No. lxii.) Raw coffee is more nutritious than roasted. A strong infusion of coffee without sugar or milk often removes megrim or hemicrania; and also in some

cases of asthma, either alone or with tincture of opium, it has kept off the paroxysm. Strong coffee is the best and safest means which can be employed by unprofessional persons to obviate the effects of all vegetable poisons which act upon the brain, and induce a fatal sleepiness and torpor. It is much more proper than vinegar which should never be given till all the poisonous substance has been removed from the stomach.

In some affections of the kidney and bladder, such as laxity and debility of these organs, coffee is of much service; and it has been stated by some writers that calculous complaints have diminished since its more extensive use.

Caffeina has not yet been used extensively in medicine, but Geiger justly anticipates that a principle so rich in nitrogen will be found to be an important medicinal agent. It is a powerful stimulant.

A beautiful green, which is unchangeable, and resists the action of acids, light, and moisture, may be precipitated from a decoction of decayed coffee, by means of pure soda. [Cafeic Acid.]

COFFEE TRADE. Referring to the Natural History Division for an account of the botanical relations of the coffee-plant, and of the mode of preparing the bean or berry for the market, we shall here offer a few observations on the coffee-trade—not simply in its buying and selling, but also in relation to the apparatus for preparing it.

Coffee beans should not be roasted long before they are ground, nor long before they are to be made into a decoction; the retention of the aroma, and of all the good qualities in the coffee, depends on this. About half an ounce of coffee powder should be used for every eight ounces (half a pint) of water. In Britain the roasting is generally carried too far. It was an endeavour to establish an improved mode of roasting coffee that led to the death of Mr. Dakin, of St. Paul's Churchyard, in 1848. His plan consisted in placing the coffee in a cylinder lined with silver, and in enclosing this cylinder within a cellular steam oven, or cylinder, patented by other parties. The heat attained within the oven was very great, and the metal of the oven was not sound enough to resist its action: an explosion ensued, with a fatal result. The silver or silvered cylinder was an intended means of retaining the fine qualities of the coffee, without acquiring any defective qualities during the roasting.

Considerable ingenuity has been displayed in devising apparatus for preparing coffee for the table. The ordinary coffee pot is the plainest and simplest of all; there is no contrivance for filtering the coffee. In Dresden and other parts of Germany, a thick piece of flannel or some other woven material, is laid in a funnel; the ground coffee is placed on the flannel; and the boiling water filters through the coffee, the flannel, and the funnel, to a vessel below—carrying with it the flavour of the coffee without the grounds or sediment.

Platow's Automaton Coffee Pot has for its object to make coffee in less time and in a better manner than by the ordinary method. The machine consists of two parts. There is at the top a glass vase which screws off and on by means of wooden handles, and is furnished with a long narrow straight tube, resembling the pipe of a common funnel, and reaching nearly to the bottom of a metallic urn placed beneath the vase. Boiling water is poured into the vase in quantity sufficient for the coffee to be made; and this is allowed to descend into the urn. The ground coffee is then placed within the vase, on a small perforated silver plate. A lamp containing spirit or naphtha is placed beneath the urn; and in a short time the peculiar action of the apparatus developes itself. The steam formed on the surface of the water in the urn forces, by its elasticity, the water up the tube into the glass vase; where it acts upon the coffee in the usual way for extracting the qualities of the berry. When the coffee is so far prepared and is required to be *fined*, the lamp is removed, the formation of steam ceases, a partial vacuum is formed in the urn, and the external atmosphere, pressing on the open vase, presses or strains the coffee, first through the grounds and then through the perforated silver plate; so that it trickles into the urn in the state of a pure bright decoction. It is thus seen that the liquid makes two descents and one ascent between the vase and the urn, during the process. In a cheaper form of the apparatus, a common fire or a lamp is used instead of a spirit lamp.

A coffee-pot of rather complicated structure was patented by Mr. Andrews of Wolverhampton, in 1842. This coffee-pot had no less an adjunct than a small forcing-pump, placed near the handle. The boiling water was poured in the forcing-pump, while the ground coffee was put in a perforated vessel in the middle of the coffee-pot; and the hot water, being forced by the pump, was made to saturate the ground coffee in a way which (we presume) was supposed to produce a result adequate to the costliness of the apparatus.

Waller's Coffee Pot, patented in 1847, differs in many particulars from all the others. A horizontal partition, perforated near the centre with fine holes, divides the vessel into two equal chambers; an open pipe leads nearly from the top of the upper chamber to near the bottom of the lower chamber; and another pipe leads from the perforations some way down the lower chamber, with a tap or cock which can be worked by a handle protruding through the side of the coffee-pot. The requisite quantity of water, either hot or cold, is poured into the upper chamber, and allowed to flow through the perforations and small pipe into the lower chamber; the ground coffee is placed on the perforated plate; the spout is closed with a cork or plug; and the vessel is placed on the fire. As the water becomes heated, the steam generated has no outlet upwards or sideways, and it therefore presses on the water, and forces it up the long pipe, whence it falls into the upper chamber, upon the ground coffee. When all the water is thus forced up, the coffee-pot is removed from the fire, the vacuum in the lower chamber is condensed, the plug is removed from the spout, the top of the short pipe is opened, and the water trickles through the ground coffee and through the perforations into the lower vessel, imbibing all the soluble and aromatic properties of the coffee as it descends.

Many other varieties of coffee apparatus have been invented within the last few years; but they need not be separately described here.

Attention has been directed within the last few years to the properties of coffee leaves, as a substitute for the berry. It has been ascertained, by a mercantile house at Singapore, that roasted coffee leaves could be there sold at twopence per pound; and in 1853 an attempt was made to introduce this article into the English market—hitherto without much success. An essence of coffee is made for keeping; it consists of a highly concentrated infusion, mixed to the thickness of treacle with chicory and burnt sugar, and kept cool in well corked bottles; it is used to make coffee beverage quickly under special circumstances, but it is not quite equal to fresh coffee. Coffee syrup is the essence combined with sugar and milk, and greatly evaporated; it becomes coffee paste, and then coffee candy, if the evaporation be still further continued.

Coffee is adulterated to an enormous extent, as sold in the retail shops. Chemists have detected, mixed up with it in various ways, the following substances—acorns, almonds, beans, beech-mast, beet-root, chick peas, currant seeds, chicory, gooseberry seeds, holly berries, lupins, rice, rye, sassafras, water flag seeds, and many others. The chief among these adulterants is chicory, which is often mixed in enormous quantity with cheap coffee. The best security against adulteration is perhaps to purchase the coffee unground.

We now present a few figures concerning the coffee trade.

It has been estimated that the quantity of coffee annually exported from the countries where it is grown cannot be less than 120,000 tons, or 2,400,000 cwts. Nearly all the coffee now consumed in Europe is the produce of trees propagated from a single seed, sent from Mocha to Batavia in 1698; the progeny of this first plant was sent to the West Indies in 1718; and thus the great coffee plantations began. The chief coffee growing countries are Ceylon, Brazil, Central America, Cuba, Hayti, Java, British West Indies, Guiana, French West Indies, Porto Rico, Sumatra, Isle of Bourbon, Manilla, and Mocha; these are enumerated nearly in the order of their importance. England purchases far less coffee than France, Germany, or the United States, in which countries coffee drinking is more prevalent. Our total imports, in certain years, were as follows:—

1845	50,000,000 lbs.
1850	51,000,000 „
1855	64,000,000 „
1858	61,000,000 „

This list does not denote the quantity of coffee *used* in the United Kingdom; for a greatly-fluctuating proportion is every year re-exported. The quantity retained for home consumption varies from 35,000,000 to 40,000,000 lbs. per annum. In 1844 the importations from British possessions were about equal to those from foreign possessions; but since that year the former have more and more predominated; until at length in 1858 the ratio was 51 millions of pounds British against 10 millions foreign. Variations in the import duty have had much to do with these fluctuations.

COFFER-DAM. A temporary enclosure around the position intended to receive the foundations of a structure to be built in water, so constructed as to allow the water to be pumped out of the space enclosed, and the building operations to be subsequently conducted "in the dry." Coffer-dams are used when the depth of water at the place under consideration is very great, and the importance of the structure or the nature of the subsoil, are such as to render it inexpedient to employ the diving-bell, or to resort to the use of caissons, or of concrete foundations within close-piled enclosures. [Bridge.] They may be, according to their depth, either simple banks of earth; or timber-walls backed with earth; or double linings of timber filled in with impermeable clay; or, finally, boxes or cases of wood, filled in as before with clay. The complication of the framing, or of the cross strutting of a coffer-dam, will, of course, depend on the effort to which it is to be exposed; and in deep tidal rivers these structures become very costly and important preliminary works in the erection of bridges, docks, wharves, &c.

The thickness of a coffer-dam, of whatsoever material it may be composed, is regulated by the consideration that it must be able not only to resist the dead action, so to speak, of the water to be excluded, but also its live action, or shock. It is customary, therefore, to make the thickness of simple earthen dams equal, on the average, to their height; and for this reason their use must be confined to such positions only as would allow so much room to be devoted to the purpose, and when the depth becomes at all considerable, the mixed systems of construction must be resorted to. In the case of a simple timber dam, backed with earth, the timber acts partly to resist the statical action of the water by means of its own transverse strength, and partly to

protect the earthwork from the effects of any current which may exist in the stream; but when a double enclosure is resorted to, it is frequently so strengthened by struts and cross-bracing, that the whole of the resistance to the water is obtained from them, whilst the earth contained within the enclosure only performs the function of excluding the passage of water from one side of the dam to the other. The simple dams backed with earth are often used to protect the foundations of abutment-walls of bridges, of wharves, &c., immediately connected with the shore; whilst the double enclosure is almost always adopted when the foundations of piers, or other works in deep, tidal streams, require to be executed with particular care. It is to be observed, also, that in the construction of coffer-dams the consideration of the lateral displacement, by reason of the tendency to slip upon the bed, is of less importance when timber enclosures are used, than it is in ordinary earth-work dams, because the hold of the piles in the ground enables them to resist that particular action; whereas the earthen dams only resist by the friction upon the surface of their bases.

Assuming that in either case (that is to say, whether timber or earth-work be used) there is no danger of lateral displacement of the dam, the pressure which will be brought to bear upon the portion exposed to the dynamical action of the water is thus calculated: Taking d to represent the depth of water in feet lineal, the pressure per foot lineal of the dam will be proportional to the weight of a right-angled triangle of water, whose sides $= d$; or as a cubic foot of water weighs 62½ lbs. nearly, the pressure will be $\frac{d^2}{2} \times 62\frac{1}{2}$; and calling the length of the dam, in feet, l, the total pressure will be $= l \times \frac{125 d^2}{4}$.

According to the laws of hydrodynamics, the centre of pressure is of course situated at $\frac{1}{3} d$ from the bottom; and therefore, if only one stay be necessary, it should be placed at that point. If more than one stay be necessary, on account of the great height of the dam, the succeeding ones must be placed at the *centres* of pressure of the other portions; or in other words, if three stays be employed, they must respectively be fixed at points measuring $\frac{7}{45}$, $\frac{15}{45}$, and $\frac{25}{45}$ from the bottom of the dam. In ordinary cases the dam is, however, made of a rectangular section, and does not depend on struts; and when this form is adopted, the thickness, or width, may be calculated as follows. Calling w the mean weight of the dam per cubic foot, h its height in feet, and d the depth of water; then t, the thickness, should be, $t = \frac{\sqrt{125\, d^3}}{3hw}$; for the moment of resistance of the dam is $= \frac{ht^2w}{2}$, and that of the water is $= \frac{125\, d^3}{6}$. According to Mr. Neville (whose paper on this subject, in the 'Civil Engineers' and Architects' Journal,' 1849, contains the best practical information on the subject yet printed), it is customary to take the weight of a cubic foot of a coffer-dam at 90 lbs., but to reduce it to 30 lbs. per foot, if the water should be able to get under its seat. If struts should be used, Mr. Neville states that the distance of their feet, called k, should be made equal to $\frac{125\, d^3}{6hwt} - \frac{t}{2}$, following, however, the notation adopted above, and supposing t, the thickness of the rectangular portion of the dam, to be given. This is usually the case in practice; for the hydroscopic qualities of the clay, used to fill in the space between the timber casings of such dams, requires that they should be at least from to 2 to 3 feet apart; generally speaking the distance between the outer and inner rows of piles is made 4 feet.

In the execution of coffer-dams, the system usually adopted is to drive *guide-piles* to mark the general limits of the enclosure. Horizontal *whales*, as they are called, are then attached to the guide-piles, and they serve to keep in place the *close* or the *sheet* piling, which forms the exposed face of the dam; occasionally, when great perfection of execution is required, the close piling is made with vertical grooves, or, to use the workmen's phrase, it is grooved and tongued. The intermediate space between the inner and the outer rows of sheet piling is then filled in with impermeable clay puddle; and when all connection between the external and the internal waters is thus intercepted, the latter is pumped out, so as to allow the ordinary building operations to be carried on as though on the dry land.

Very good descriptions of coffer-dams actually executed, under difficult circumstances, are to be met with in Perronet's 'Nouvelle Architecture Hydraulique;' in Sganzin's 'Cours de Construction;' in Semple's 'Treatise on Building in Water;' and in Cressy's 'Treatise on Bridges and Vaults.'

COFFIN, the box or chest in which dead bodies are put into the ground; also a mould of paste for a pie: from the Latin *cophinus*, and that from the Greek *κόφινος*, which properly meant a wicker basket. Wyntown, in his 'Chronicle,' uses *cofyne* for a shrine or box, and in the 'Pericles' of Shakspere—at least of his time—it is so used: "Bid Nestor bring . . . . my casket and my jewels; and bid Nicander bring me the satin coffin." We have another instance of the use of the word coffin for an ordinary chest in the Wardrobe Accounts of Edward IV., 8vo. Lond., 1830, p. 125: "For closyng and fastenyng of divers *cofyns* of fyrre, wherein the kyng's books were conveyed and caried from the king's great wardrobe in London to Eltham, v^{d}." The kistvaen, or coffin composed of rough stones, set edgewise at the sides and ends, and covered with one or more flat stones, was common among the Britons; they are found in caverns, &c. in various parts of the kingdom. Sir Christopher Wren found stone coffins of the Saxon times, at the rebuilding of St. Paul's: and Gough adds that, from the 9th century to the reign of Henry III., stone coffins were in general use, that is, for persons of the higher classes. The bodies of the common people, not only in the Norman but also in the English æra, as we see in the illuminations of ancient missals, were only wrapped in cloth, and so put into the ground. In this manner, Matthew Paris informs us, the monks of St. Alban's were buried, till the time of Abbot Warin, who died in 1195. He ordered that they should be buried in stone coffins, as more decent. Matthew Paris, on this occasion ('Vit. Abb. S. Alb.,' p. 95), charges him with innovations on established customs, to please the multitude. Many stone coffins remain of the 11th, 12th, and 13th centuries with crosses, crosiers, mitres, and inscriptions carved on the lids. Strutt says, in the reigns of Henry V. and VI., stone coffins were made with necks, distinguishing the head and shoulders. Coffins both of lead and wood are of early use. The former occur in numerous instances through different centuries: and that the Saxons buried in coffins of wood, occasionally, we have the testimony of Bede. Ceadda was so buried ('Hist. Eccl.,' l. iv., c. 3), as was Etheldreda, wife of Egfrid, king of the East Angles. (Ibid., l. iv., c. 29.) Sebba, king of the East Saxons, was buried at St. Paul's in a coffin of gray marble. (Ibid., l. iv., c. 11.) The forms and ornaments of various ancient coffins, mostly of stone, may be seen in the plates of illuminations in Strutt's 'Manners and Customs,' vol. i., pl. xxxix., xlv., lxvi,. and in Gough's 'Sepulchral Monuments.'

COGNOVIT, or more technically *cognovit actionem*, is a formal acknowledgment or admission by one person, commonly a defendant, that another person, ordinarily the plaintiff in an action, has a good right of action or just claim against him. Thus it is not unusual for a defendant, when served with a writ for a claim to which he has no answer, to give a warrant of attorney as it is called; that is, in effect, to admit the plaintiff's claim, so that all expense is saved, and judgment at once entered up for the plaintiff. In almost all cases the defendant's failure to appear to a writ is, in effect, a *cognovit actionem*, as the plaintiff may, if the action be for the recovery of a specific amount, at once sign judgment for that amount. If the action be for damages, he may sign an interlocutory judgment by default after certain forms, and afterwards ascertain the amount for which he is entitled to *final* judgment by the verdict of a jury. The advantage of having a claim admitted beyond dispute has made it a common practice for a debtor to strengthen the security of his creditor by executing a warrant of attorney to an attorney named by the creditor, authorising him to confess a judgment in an action to be brought by the creditor against the debtor for the specific sum due to him. In order to prevent debtors being defrauded, such a warrant of attorney or cognovit is of no force unless there be present an attorney of one of the superior courts, on behalf of the party who gives it, expressly named by him, and attending at his request, to inform him of the effect of the instrument before he executes it, and who must subscribe as a witness to the execution, and declare himself to be the attorney for the party. In order to be effectual as against the assignees of the debtor, if he should become bankrupt or insolvent, warrants of attorney and cognovits must further be filed in the Court of Queen's Bench within twenty-one days after execution.

(1 & 2 Vict. c. 110. Chitty's *Practice*, by Prentice, tit. 'Cognovit' and 'Warrant of Attorney.')

COG-WHEEL. The tooth-wheels used in machinery for the transmission of motion are called *cog-wheels* when the teeth are made of *wood*; when the teeth are of iron such wheels are simply called *tooth-wheels*, and subsidiarily they are known as pinions, bevilled wheels, annular, or crown wheels, according to their sizes and their relative positions with respect to the rest of the machinery. [MACHINERY.] Both cogs and teeth, however, are the projections on one wheel fitting into the space left between the two teeth of the corresponding wheel, in such wise that one of those wheels cannot move without putting the other in motion. The *thickness* of cogs, or teeth, is measured on the *pitch circle* of the wheel; and the interval between one cog and the next to it is called the *depth*, and is made equal to the thickness, augmented by from $\frac{1}{10}$ to $\frac{1}{15}$ of that dimension, according to the perfection of the work. The *breadth* of a cog is its dimension upon the axis of rotation; the portion of its height (or of the clear united length from the top to the bottom of the cog) which lies beyond the pitch circle is called the *face*; and that which lies within that circle is called the *flank*. The *pitch* of wheels of this description is the distance measured from centre to centre of the cogs, or of the intermediate spaces.

Cog-wheels are usually made with cast-iron frames, in which rectangular holes are left to receive the wooden cogs or teeth, and these pass through the whole thickness of the rim, and are retained in their situations by means of keys or wedges. The cogs are thus wedged up before being cut into their definite form, and the latter must be set out with all the care usually observed in executing teeth-wheels. [TOOTH-WHEEL.] When well made, cog-wheels are preferable to ordinary teeth-wheels, especially in large work, on account of their working more smoothly and with less noise; but great precautions must be observed in the selection of the wood of which the cogs are made, and

they must be protected from the effects of humidity. Hornbeam, or box-wood, are the materials best fitted for this purpose. Cog-wheels should be greased, and a little black-lead may be mixed with the grease; but oil should not be applied to them. (See Camus, 'Treatise on the Teeth of Wheels,' translated by Hawkins, Lond. 1842; Buchanan's 'Essay on the Teeth of Wheels,' Lond. 1808, &c.)

COHESION. [ATTRACTION.]

COHESION, MAGNETIC. [MAGNETISM.]

COHORT was a division of the Roman legion. The term (cohors, or chors, the Greek χόρτος) originally signified an enclosure for sheep or poultry, and was afterwards used to designate the number of men which could stand within such an enclosure. The Roman legion, as well as the citizens at the census [CENSUS], was subdivided into centuries. A century did not always consist of a hundred; the number varied. A legion consisted of ten cohorts; each cohort contained three maniples, and each maniple two centuries; hence there were thirty maniples and sixty centuries, and in the whole legion there must have

been sixty centurions. The different centurions received names indicative of their rank. Of the two centurions in a maniple, one ranked before the other, and had the title prior; the second was called posterior. The first centurion of the first maniple had the charge of the eagle, the great standard of the legion; he was ranked with the equites. He was called centurio primi pili (Livius, xxv., 19), or simply primus centurio, or primus pilus (Cæsar, 'De Bell. Gall.' ii. 25). The office was lucrative, but it was not always the reward of merit; favour or money in some cases procured it (Cicero, 'Pis.' 36); under the emperors it was bestowed generally from caprice (Vegetius, xi. 3, in Pitiscus, 'Lexic. Antiq. Rom.') The badge of a centurion was a vine rod, which the soldiers sometimes felt (Tacitus, 'Ann.' i. 23).

The cohortes alares, or alariæ (Liv. x. 40, 43), were the troops of the auxiliaries and the allies which were stationed in the wings (alæ).

The cohors prætoria was a select band which usually attended the prætor (Sallustius, 'Catil.' c. 60; Pitiscus, 'Lexicon Antiquit. Rom., in Cohors, Centurio.')

END OF VOLUME II.

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MDZ Münchener DigitalisierungsZentrum Digitale Bibliothek

Knight, Charles

The English Cyclopaedia a new dictionary of Universal Knowledge

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